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GEOLOGICAL SURVEY OF CANADA

G. M. DAWSON, C.M.G., LL.D., F.R.S., Director

ANNUAL REPORT

(NEW SERIES)

VOLUME XI

REPORTS A, D, F, G, J, L, M, R, S,

1898

OTTAWA

PRINTED BY S. E. DAWSON, PRINTER TO THE KING'S MOST EXCELLENT MAJESTY

1901

No. 715

To the Honourable

CLIFFORD SIFTON, M.P.,

Minister of the Interior.

SIR,—I have the honour to submit Volume XI. (New Series) of the Reports of the Geological Survey of Canada.

The volume comprises 853 pages. It is accompanied by seven maps and illustrated by twenty plates, besides a number of figures in the text.

The several parts composing the volume have been issued previously, as completed, and may be purchased separately at the prices noted on page ii.

I have the honour to be, sir,

Your obedient servant,

GEORGE M. DAWSON,

Director.

OTTAWA, January, 1901.

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GEOLOGICAL SURVEY OF CANADA
G. M. DAWSON, C.M.G., LL.D., F.R.S., Director

SUMMARY REPORT

ON THE

OPERATIONS OF THE GEOLOGICAL SURVEY

FOR THE YEAR 1898

BY

THE DIRECTOR

OTTAWA
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674

SUMMARY REPORT

ON THE

OPERATIONS OF THE GEOLOGICAL SURVEY

FOR THE YEAR 1898.

OTTAWA, 15th January, 1899.

The Honourable CLIFFORD SIFTON, M.P.,
Minister of the Interior.

SIR,—In accordance with the provisions of the Act relating to the Geological Survey, I have the honour to submit the subjoined Summary Report of the work carried out by the Survey during the calendar year 1898, giving, in abstract form, an account of the explorations and surveys completed or in progress, together with a record of the investigation conducted in the office, publications, additions to the collections, organization, changes in the staff and other matters relating to this Department of the public service.

Information given in Summary Report.

In work like that carried on by the Geological Survey, much is necessarily dependent on the initiative of individual members of the staff, and these gentlemen are consequently requested to embody in the preliminary reports on their operations, in as much detail as may appear to be desirable, the more important results of their investigations, particularly such as may be of immediate value to the public from an economic standpoint. This is the more appropriate and necessary in view of the fact that the complete examination of any particular district or subject, must often occupy several years of field-work before it can be completed, and further time may have to be occupied in the examination of specimens, the collation of results and the compilation and engraving of maps before the whole can be prepared for issue in the form of a comprehensive report.

Separate publication of completed reports.

In order to facilitate as far as possible the early appearance of such finished reports, it has been the custom for some years to print and issue each of these in separate form, as soon as completed. Such separate issues are subsequently collected in an annual volume, for per-

manent record and for distribution to Parliament and to such libraries, public institutions and exchanges as are entitled to receive it.

Issue of Volume IX.

In consequence of pressure of work in the Printing Bureau, it was not possible to complete Volume IX. of the new series of Annual Reports in the early part of the past year, but this volume has now been printed, bound and issued in English, while the French edition is approaching completion. It contains, as usual, the Summary Report of the year which gives nominal date to the volume, (thus carrying on the general record of the operations of the Department,) and six other separate reports, as follows :—

Contents.

Summary Report of the Geological Survey Department for the year 1896, by the Director.

Report on the Doobaunt, Kazan and Ferguson Rivers and the North-west Coast of Hudson Bay, by J. B. Tyrrell.

Report on the Geology of the French River Sheet, Ontario, by R. Bell.

Report on a traverse of the northern part of the Labrador Peninsula from Richmond Gulf to Ungava Bay, by A. P. Low.

Report on the Geology of South-west Nova Scotia, by L. W. Bailey.

Report on the Section of Chemistry and Mineralogy, by G. C. Hoffmann.

Report on the Section of Mineral Statistics and Mines, by E.D. Ingall.

The volume comprises 816 pages, and is accompanied by five maps and illustrated by twenty plates, besides a number of figures in the text.

Reprint of Yukon reports.

The reprint of the Report on the Yukon District, from Volume III. (N.S.) with parts of a subsequent report on the same district from Vol. IV. (N.S.) together with that of the three large map-sheets accompanying the first-mentioned report, was completed early in the year. This publication of 244 pages, practically embodied all the geological information available on the district to date, and the maps were corrected to January last.

Other publications.

In the palæontological series of publications, Part V. completing Volume I. of *Contributions to Canadian Palæontology*, was issued at the end of November.

The preliminary statistical abstract of the mineral production of Canada, for 1897, was completed and sent to the printer on February 23rd, 1898.

The number of maps actually printed during the year, is thirteen. Particulars are given of these and of those in progress, on a later page. The new general geological map of the Dominion, referred to in a previous Report, has been somewhat delayed by difficulties connected with the engraving work, but is now again progressing satisfactorily.

Progress of Volume X.

The printing of Volume X. of the new series of reports is now in progress, the following constituent parts being in press:—

Report on the Geology and Natural Resources of the area included by the Nipissing and Temiscaming map-sheets.

Report on the Surface Geology and Auriferous Deposits of South-eastern Quebec, by R. Chalmers.

The Mineral Resources of the Province of New Brunswick, by L. W. Bailey.

Report of the Section of Mineral Statistics and Mines, by E.D. Ingall.

Progress also continues to be made in the printing of the General Index of the reports of the Geological Survey, from 1863 to 1884, alluded to in the last Summary Report, and it is hoped that this may now shortly be published.

Increasing production of minerals.

The aggregate value of the production of minerals in Canada during the year 1897, as finally corrected and published, is $28,661,430, being an increase of about 27 per cent over that of the previous year. This is largely accounted for by the great development of gold mining, particularly in the Yukon district, the value of the gold produced being more than double that for 1896. Several other mineral products, however, likewise show a very significant growth, the percentage increases in value of some of these being as follows, according to the figures obtained by the Section of Mineral Statistics and Mines:—lead 93·7, silver 54·6, copper 46·9, gypsum 37·3, cement 36·5, nickel 17·7.

The returns for 1898 are at this time by no means complete, but they are sufficiently known to indicate that a further increase of 25 to 30 per cent in value will appear in this year as compared with 1897. As before, however, a large proportion of this increase is attributable to placer gold mining in the Yukon district.

Collection exhibited at Omaha.

A small representative collection of Canadian ores and minerals of economic value, with photographs of mines, etc., was prepared early in the year for display at the Trans-Mississippian Exhibition at Omaha. This was despatched, together with other exhibits, in charge of officers appointed by the Minister of Agriculture. From accounts since

received and from correspondence relating to this collection, it appears that it attracted a good deal of attention on the part of miners and prospectors from the Western States of the Union.

Preparations for Exhibition at Paris.

The collection has since been returned, and some part of it will now be available for the much larger and more complete display of the mineral resources of Canada which it is intended to make at the International Exhibition in Paris in 1900. Much additional material will, however, be needed for this purpose, and toward the accumulation of this some preliminary steps have already been taken. It is hoped that the active co-operation of all those engaged in mining or metallurgical industries in Canada may be counted on in the effort to make the mineral and geological exhibit a thoroughly creditable and representative one, as the occasion afforded by this exhibition appears to be one of which the greatest possible advantage should be taken.

Importance of this Exhibition.

Communications are invited, in the above connection, from those interested in mining matters. It is desired, not only to exhibit mineral products for which markets may be found in Europe, but those also in which the numerous visitors from all other parts of the world may be interested; and it may be pointed out that, even in the case of products for which the chief market is to be sought in adjacent parts of the United States, no better means can be adopted of making them known than that of their proper representation at Paris. It is also to be borne in mind that the adequate display of substances of purely local consumption, will at least evidence their existence in the Dominion and that of the industries depending on them, attracting the attention of those engaged in similar industries or interested in connected processes and machinery, as well as inducing the immigration of workmen skilled in such industries.

Specimens sent to Imperial Institute.

Specimens of minerals of commercial importance have been sent from time to time, during the year, to the Imperial Institute in London, some in response to inquiries, others, when there appeared to be a good prospect of establishing a profitable market for them. Some trouble has been taken, for instance, to obtain representative specimens of Canadian felspars from deposits capable of yielding this mineral in large quantity, and some of these have been experimentally fused in the kilns of the Ottawa Carbon and Porcelain Company and forwarded in that condition, together with the crude material. Felspar is extensively employed in the manufacture of pottery and porcelain, and if it can be laid down at the works in England at a satisfactory price, although the percentage of profit to be anticipated is small, there is no reason why the industry may not assume very large

Felspar.

proportions, the Canadian material being apparently quite equal to that produced in Scandinavia. Considerable shipments have already occurred to potteries in the United States.

Molybdenite. Molybdenite is another mineral for which a considerable and growing demand appears to have been established, particularly in connection with the employment of molybdenum in alloys of iron and steel. Mr. Willimott was instructed in July to visit and report upon some of the best known and most accessible occurrences of this mineral, and specimens of the more important of these deposits were sent to the Imperial Institute. As a result of this, prices were quoted for the mineral, in England, that appear to afford a good margin of profit for the working of some at least of these deposits. Large samples were also obtained from a couple of the deposits, for the purpose of ascertaining whether it might not be possible to crush and concentrate the ores containing a comparatively small amount of molybdenite. The concentration of this ore has not, so far as I am aware, yet been attempted, but acting on the kind offer of Professor J. B. Porter of McGill University, Montreal, the samples referred to have been transmitted to him and are now being made the subject of experiment in the mining laboratory of the University.

Speculative holding of mineral deposits. In connection with the above and other mineral substances which Canada is capable of producing and supplying to new markets, I may add that the greatest difficulty has been found in inducing the owners of deposits of the kind, not previously worked, to make even trial shipments of their products. Many proprietors are ready to sell undeveloped properties at good prices, but are either unable or unwilling to put the matter on a commercial basis. The inquiries received are not as a rule directed to the acquirement of deposits, but to the practical question—at what price and in what quantity can a given mineral be delivered at a stated market. The acquisition and locking up of mineral deposits for purposes of speculation only, has in fact become a serious deterrent to the development of Canadian mining, to which the attention of the proper authorities in the several provinces might, it is believed, be usefully directed.

Minerals specially inquired for. Among the minerals for which special inquiries have been received during the year, the following may be mentioned. Some of these have not yet been found in Canada, or not in quantities that appear to be of commercial importance, but most of them may be looked for, in different parts of the Dominion, with prospects of success, while others are already well known.

Asbestus, Antimony ores, Bismuthenite, Corundum, Chromic Iron, Felspars, Fire Clays in British Columbia and the North-west Territories,

Fluorspar, Graphite, Gypsum, Iron-pyrites, Iron Ores (Bessemer and titaniferous), Limestone (pure, for manufacture of calcium carbide and dolomitic or magnesian limestone for use in connection with wood-pulp manufacture), Molybdenite, Mispickel in Ontario, Mica, Marble for ornamental purposes, Magnesite, Natural Gas in Quebec, Nickel, Osmium, Platinum, Pottery-clay in the North-west, Peat, Phosphate or Apatite, "Quartz" for paviers of grinding-pans, Sand for glass-making and for "sand-blasting," Steatite or Soap-stone, Talc, Tungsten ores (wolframite or scheelite), Zinc ores.

Nearly all the substances above noted were required for purchase or immediate utilization in connection with different industries, and a large proportion of the inquiries came from Great Britain, the United States and the continent of Europe. Whenever possible the inquirers have been either placed in correspondence with persons working or owning the minerals asked for, or have been informed of the localities and under what conditions these minerals are known to occur.

Information supplied by the Department.

As usual, a very large number of applications have been received by the Department for information of various kinds, referring to mines and minerals, geological and geographical points and a wide range of other technical subjects. Much of the correspondence of the office relates to such questions, many of which require some time and research in order to obtain or collate the facts asked for. This is particularly the case in connection with boring operations, and the very numerous samples of rocks, ores, fossils, botanical and geological specimens, etc., sent in for examination or determination. It may be added, that, while the Department is ready to undertake such examination and determination of minerals, etc., as may appear to be necessary or reasonable in each case, assays or analyses of ores and minerals are made only in the case of those that appear to be of public interest or importance.

Educational collections.

During the past year, twenty-five collections, comprising an aggregate number of over 2000 specimens, have been prepared and presented gratuitously to approved educational institutions in various parts of Canada. The number of such collections that can be made up being necessarily limited, while the demand for them appears to be a continually growing one, more care is now necessarily taken than in former years to ascertain that the institutions supplied are of such a grade that specimens of the kind can be beneficially employed in them. In the case of schools in which natural science forms no part of the curriculum, it would appear that but little use can be made of such collections, the cost of which to the Department is considerable, in time and work, as well as in the expenditure annually necessary to procure suitable material.

While it is necessary in this Report to again allude to the ever-present danger of the loss by fire of the valuable collections and records of the Survey, still housed in the old and inadequate building on Sussex Street that has been occupied since the removal from Montreal, it may be added that there now appears to be some prospect of the early erection of a new and spacious fire-proof building. It should be fully recognized that the loss of the collection, with its numerous "type" specimens, resulting from the work of the staff for more than fifty years, would not only be a national calamity, but one which would be deplored by scientific workers the world over. The rapidly increasing importance of mining in Canada, alone, should ensure the immediate provision of suitable quarters for the museum and staff of the Survey, in which it may be possible to afford something like an adequate presentation of the mineral resources of the country to all visitors to the capital. Museum building required.

In connection with the value of type specimens, of whatever kind, the following observations by Professor O. C. Marsh, being part of a communication made by him to the International Congress of Zoology at Cambridge, England, in August last, may be quoted here, as the importance of such specimens is not so generally understood as it should be :— Safeguarding of type specimens.

"The careful preservation of their own type specimens is a sacred duty on the part of all original investigators, and hardly less so of those who are the custodians of such invaluable evidences of the progress of natural science. * * * For the preservation of type specimens, fire-proof buildings are indispensable. I recall no less than five Museums of Natural History, in America, that have either been destroyed, or their contents consumed, or seriously damaged by fire, since I became actively interested in natural science."

Necessary routine work in the office, together with the supervision of the publication of the reports, has occupied the greater part of my own time during the year, but it was found possible also to make some excursions in the field, in connection with the general control of the work there in progress and for the purpose of correlating the surveys and observations of different members of the staff. This forms a very necessary part of the scheme of the Survey, which implies a uniformity of plan in the definition and mapping of the formations of all parts of Canada. It is recognized that such supervision should not be confined merely to the published matter of the several reports, but should include an actual knowledge of the main facts, of such a character as to enable the Director to assist the individual workers in reaching a concurrent rendering of their results for presentation to the public. An extension Work of the Director,

of consultary relations of the geologists working in adjacent fields, is also to be desired and it is hoped that this may be more fully attained in future.

Visit to Rivière Blanche.

Early in May, at the request of and in company with the Hon. Sir Henri Joly de Lotbinière, a day was spent in a visit to the scene of a disastrous landslip that had occurred on the Rivière Blanche, in Portneuf county, Quebec. The peculiar features of this landslip appearing to merit further investigation, Mr. R. Chalmers was subsequently instructed to visit and examine the place. Some notes on the occurrence are given in his report, below, and I have also presented a short account of the disturbance, dealing particularly with its geological aspects, to the meeting of the Geological Society of America, lately held in New York.

Mines at Calumet Island.

At a later date, advantage was taken of an excursion to the Calumet Mining Company's property, to visit the interesting deposits of lead and zinc ores which are being worked by that company on Calumet Island in the Ottawa River. Dr. R. W. Ells has embodied some notes on this mine in his report, given on a later page.

Inspection of boring work, etc.

In August, it became desirable that a personal inspection should be made of the boring operations in progress in northern Alberta, and on the 10th of that month I left Ottawa for that purpose, going as far as Victoria, on the Saskatchewan, and spending a few days at Edmonton and in its vicinity. Subsequently, visits were made to Kamloops and Vernon in British Columbia, in connection with further details required for the Shuswap map-sheet, now nearly ready for issue, after which the Crow Nest Pass railway was taken to Fernie, for the purpose of noting the progress made in opening up the coal-field traversed by this line, with a view to further geological surveys. Ottawa was reached on my return, on September 13th.

Localities visited in Nova Scotia.

Leaving Ottawa again on September 25th, nearly two weeks were spent in Nova Scotia in connection with the geological questions which have arisen in regard to the mapping of some of the rock-series in that province. In company with Dr. H. M. Ami, who had been instructed to continue his work of obtaining all possible palæontological evidence on the points at issue, visits were made to representative sections in the vicinity of Wolfville, Horton, Parrsborough, Harrington River, Union and McAras Brook, Arisaig. Dr. Ami in his report presented in a later part of this Summary, gives some account of the results so far reached by him in the investigation, on which he has been employed for a part of each summer during several years. These results are of importance, inasmuch as the issue of several maps, now

engraved, had to be delayed pending the determination of the taxonomic position to be assigned to some of the formations included by these sheets. The inspections which I have made in this connection, enable me to characterize the stratigraphical work, which on these map-sheets has been chiefly carried out by Mr. H. Fletcher, as most complete and accurate ; so that whatever differences of opinion may still remain in regard to the age to be assigned to the formations in question, must depend upon the weight to be given to the fossils contained in these rocks in their relation to palæontological standards, recognized by geologists generally in other parts of the world.

Gold on the North Saskatchewan.

While at Edmonton, I embraced the opportunity of gaining some further information in regard to the gold of the North Saskatchewan. Much interest is now being taken in this question in connection with the introduction of dredging machinery on a considerable scale, and a short general review on the subject may thus appropriately be given here.

Previous reports.

The occurrence of placer gold on the Saskatchewan and other rivers in Alberta and Athabasca, its distribution and the sources from which it may have been derived, have been referred to in several previous reports of the Geological Survey ; but recent systematic efforts to establish dredges for gold mining on the North Saskatchewan, together with certain late additions to our knowledge of the problems involved, seem now to warrant a further notice of the subject.

Occurrence of the gold.

Gold in fine scales and particles, generally so minute as to require the employment of mercury in collecting it, is now known to occur on almost all the rivers running eastward from the Rocky Mountains, to the north of the International boundary, wherever these have been prospected. To the south of the Peace River, this gold, in any workable quantity, seems invariably to characterize a portion of the length of each of the rivers, giving out to the westward before the base of the Rocky Mountains is reached, and to the eastward along a less well defined line, but one probably due, in this case, to the local substitution of sand and clay banks and bed for the gravel bars of the upper and more rapid parts of the streams. The Peace River and the Liard, rising to the west of the Rocky Mountains proper, among rocks known to be auriferous, contain more or less gold throughout their lengths, or to points in their lower courses where the changed conditions of flow, above alluded to, render the collection of any minutely divided gold which they may still carry practically impossible. In other words, in these two rivers, and possibly also in some still further to the north, a considerable part at least of the contained gold comes directly from their upper tributaries ; while in the case of the Athabasca, the North

Saskatchewan and other rivers further to the south, the evidence at first sight appears to be entirely against the possible derivation of gold from the mountains to the westward.

Dr. Selwyn on Saskatchewan gold.

In the Report of Progress for 1873-74, (p. 58) Dr. Selwyn, who had descended the North Saskatchewan in a boat in 1873, notes that the first signs of gold washings were observed rather more than forty miles below the mouth of the Brazeau, and continued for some miles below Edmonton. He states his belief that the gold is not derived from the mountains, as none of the miners had ever been able to find any above Rocky Mountain House, and his conclusions are that it came as a part of the glacial drift, with the Laurentian and other crystalline rocks derived from the belt which extends north-westerly from Lake Superior to the Arctic Sea.

Gold in southern Alberta.

In my report on the southern part of Alberta, contained in the Report of Progress for 1882-84 (p. 152 c.) it is noted that fine gold is found, when looked for in favourable localities, in all the streams in that region, but ceases to occur before the base of the mountains is reached, at or near the western limit of the glacial drift from the eastward. The facts are considered fully to confirm the hypothesis advanced by Dr. Selwyn.

Mr. Tyrrell on Saskatchewan gold.

Mr. J. B. Tyrrell's report on Northern Alberta, forming part of the Annual Report, Vol. II. (N.S.) 1886, (pp. 109, 164, 131 E,) contains additional observations on the occurrence of gold. Near Goose Encampment, on the Saskatchewan, about fifty-five miles above Edmonton by the river, on Sections 35 and 36, Township 50, Range IV., west of the Fifth Meridian, are extensive exposures of the Lower Laramie rocks, including a very thick bed of lignite-coal. At this place the coal has been largely burnt out, leaving mounds and slopes of vitrified materials baked shales, etc., and specimens of these and of the ash of the coal-bed were proved on assay to contain traces of gold. The gold must, of course, have existed in these rocks previous to the combustion of the coal, but it may have been to some extent concentrated in the specimens showing actual fusion. It is noted by the author that this is about the highest point at which gold in paying quantity has been found on the river, and that the miners state it is in this vicinity found in a somewhat coarser form than usual. The occurrence of gold in the Laramie rocks, Mr. Tyrrell points out, involves, in connection with the origin of gold on the Saskatchewan, the origin of the materials of these rocks; and this, he explains, may have been in the Selkirk Ranges of British Columbia, at a time antecedent to the elevation of the Rocky

Mountains proper. He finds no reason to deny, however, that some part of the gold may have been received from the eastern glacial drift.

In 1895, when for a short time at Edmonton, some further notes on the gold industry on the Saskatchewan were obtained by the writer. These are referred to in the Summary Report for that year (p. 16 A), where it is stated that the principal paying bars occur along that part of the river extending from about sixty miles above to about sixty miles below Edmonton, but that in late years bars had been worked as far down as Battleford, some 250 miles below Edmonton. The number of men employed in gold mining, for longer or shorter periods in that year, was estimated at about 300. In consequence of favourable reports brought back by a few miners from the Athabasca, a rush occurred also to that river, but without leading to any important results, as the men going there were for the most part inexperienced in gold washing. Observations in 1895.

In the same year, the first dredge of any considerable size was built at Edmonton, with the intention of working the submerged bars and the bed of the river, although previous to this time hand dredges and scoops of various kinds had been operated with some success. First dredge constructed.

The writer was then also informed of the working of certain gravel deposits by drifting, in the banks of the river, and of the occurrence of gold in gravels met with in sinking wells in the prairie land at some distance from the Saskatchewan. It appeared to be probable that, while some of these gravels were recent and strictly fluviatile, such as those underlying flats along the river-valley, others were referable to the deposit named "Saskatchewan gravels" by Mr. R. G. McConnell; a deposit that underlies the glacial drift of the Great Plains. As no opportunity occurred at that time of testing the last-mentioned conjecture, it was not referred to in the Report cited; but when, in the following year, Mr. McConnell had occasion to visit Edmonton in connection with the selection of a site for boring operations, he was requested also to examine the places at which such drifting had been carried on in the gold-bearing gravels. Gold in old gravel deposits.

Mr. McConnell's examination then made, proved the existence of gold in workable quantity in some parts of the "Saskatchewan gravels" underlying the boulder-clay of the plains. At a point about ten miles above Edmonton, he noted the following section in the bank, in descending order :— Mr. McConnell's observations.

		Feet.
1.	Silts and clays	7
2.	Boulder-clay	50
3.	Cross-bedded sands	60
4.	Sandy gravel carrying gold	3
5.	Laramie sandstones and shales to water level.	50
		170

He also reported that another deposit, evidently of the same character from descriptions received, was about to be worked some sixty miles above Edmonton.

Character and origin of the old gravel deposits.

Without entering into details which have been presented elsewhere, respecting the "Saskatchewan gravels," it may be explained that the deposit so named is widely distributed in the North-west, and that it has been shown to be connected with the earliest period of glaciation there, during which the western mountain region was the main source of ice. These gravels and associated sandy beds, rest directly upon the Cretaceous or Laramie rocks, and have been carried far eastward by rivers and streams discharging from the glaciers of the eastern slopes of the mountains. Their material is consequently almost entirely derived from the mountains, but none of it can be proved to have come from ranges west of the Rocky Mountains proper. They do not contain débris from the crystalline rocks of the Laurentian axis to the east and north-east, but underlie the boulder-clays characterized by an abundance of such material in the area of the Great Plains. The gold occurring in these gravels must, consequently, have been derived either from the Laramie rocks, noted as slightly auriferous by Mr. Tyrrell, or from the Rocky Mountains proper, or in part from both sources.

Possible secondary derivation of gold.

It may be pointed out that, although no auriferous veins have been found in the Rocky Mountains proper, the sandstones and conglomerates of the Cambrian rocks of these mountains have in long past ages been built up of débris from the Selkirks and connected ranges to the west, that are known to comprise ancient crystalline and metamorphic rocks and to carry gold. It is therefore not at all improbable that, in the wearing down of the Cambrian strata of the Rocky Mountains, considerable quantities of gold originally derived from the Selkirks has again been liberated and has been washed down with the material of the "Saskatchewan gravels." To this cause may probably be attributed the occurrence of small quantities of gold on the Miette River, a tributary of the Athabasca in the mountains, as mentioned by Mr. McEvoy in his report on a following page. It is noteworthy,

however, although these gravels, or the boulder-clay of western origin with which they are connected, continue to the base of the mountains, that, as already stated, gold practically ceases to the west of a certain line. This appears to show that the gold in these gravels is either far from abundant or that its distribution is local,—possibly that it is due more largely than one would be inclined to believe, to denudation of the underlying Laramie rocks. In this connection it may be added that, while at Calgary last autumn, Mr. J. McEvoy, at my request, tested the Saskatchewan gravels there for gold with entirely negative results.

Not everywhere found in older gravels.

The result of recent observations appears, therefore, to indicate that the gold found in the Saskatchewan and other rivers of the North-west, has come in part from several sources, but has been derived chiefly from the crystalline rocks of the Laurentian axis or plateau to the eastward or north-eastward, from which it has been transported with the fragments of these rocks that now form so conspicuous a part of the "drift" of the Great Plains. The recognition in late years, of the Huronian as a distinctly gold-bearing formation, in itself goes far to establish the correctness of the hypothesis originally advanced on this subject, as rocks of this formation occupy considerable areas of the Laurentian plateau.

General result of inquiry.

The gold, in workable quantities, characterizes parts of the rivers crossing a belt of country that extends from the vicinity of the base of the mountains, for a variable distance eastward. This distribution has led to a popular belief that some ancient system of streams has carried the gold from north-west to south-east, or in the opposite direction, parallel to the base of the mountains, forming a wide belt of auriferous alluvium in the direction of its flow. What has already been said will, however, show that the existence of such a belt is in all probability due to other circumstances, and that the gradual cessation of payable bars along the rivers to the eastward, results chiefly from the diminished slope of the country and the consequently reduced erosive and sorting power of the existing rivers.

The North Saskatchewan, has hitherto been by far the most important stream upon which gold mining operations have been carried on, and is the only one which has offered a continuous and somewhat considerable output of gold. The length of the river upon which work has been found to pay, under favourable conditions, is, as already defined, about 120 miles; Edmonton being situated almost in the centre of this length of the river. Up to the present time, gold washing has been prosecuted almost entirely by hand or with the aid only of very rude mechanical appliances for lifting small quantities of gravel from

Gold mining on North Saskatchewan.

the submerged bars and bed of the river. The prosecution of this work has been desultory, being practically limited to the low-water stages of the river, and even then conducted by a number of men who, generally, wish to devote only a part of their time to such work; influenced largely by the inducements offered by employment in other directions. It must be added, however, that experience here, as elsewhere in regard to river-bar mining, shows that the best returns are obtained from the first working of such bars, and that, although more or less re-arrangement of material and renewal of accessible gold is brought about each year when the river is in flood, the naturally exposed bars rapidly deteriorate in their yield. For this reason, except at unusually low water, a number of the miners now devote themselves to the working of layers of gravel covered by lighter sandy deposits along the banks of the river, and that these often carry a considerable amount of gold, is shown by the fact that some men were engaged, with profit, during the past year (1898) in removing from five to eight feet of sand, shovelling underlying gravel from the pit thus formed, wheeling it thirty or forty yards to the edge of the river and washing it there by hand with an ordinary "grizzly."

First work on bars most remunerative.

Dredges on the North Saskatchewan.

The steam dredge constructed in 1895, and to which allusion has already been made, was at the time of my visit to Edmonton last autumn, laid up some way up the river, and no favourable accounts were received of the results so far attained. I was able, however, to visit the other steam dredges on this part of the Saskatchewan, beginning with that of the Star Mining Company of South Edmonton.

Star Mining Company.

This was found at work about two miles above Big Island (or thirteen miles above Edmonton). It has a twelve horse-power engine and is capable of raising gravel from a depth of about ten feet. Three men and a boy were employed and the returns were stated to amount to from \$25 to \$40 worth of gold per diem. The gravel is said to average about 40 cents worth of gold to the cubic yard, without the very fine gold, which is known to be lost because of the comparatively imperfect construction of this small dredge. This dredge is stated to be paying well.

Loveland Brothers.

A much larger dredge, belonging to Loveland Brothers, was found at work in the channel south of Big Island. This is a well constructed machine, with two twenty horse-power engines, one to actuate the bucket, the other to pump water for washing the gravels raised. It had just been completed and some of the appliances were of a temporary character, and no records of work were available. About two miles above Edmonton, a small dredge belonging to Dr. Bowers was visited, but was not at work. Like those above described, it is a

dipper dredge, but is provided with a truck drawn upon inclined rails to the stern, where the gravel is screened in a revolving perforated drum before washing.

Other dredges on the river.

Another dredge, belonging to Mr. Braithwaite, was lying at the bank of the river near Edmonton. This is provided with a small engine for pumping water. It has two longitudinal wells in the hull, in each of which a bucket or scoop attached to a beam is operated. Another dredge, belonging to Mr. Brindley, lay not far from the last, but is still simpler in construction. It is said to produce about $10 worth of gold a day when at work, but had lately been employed in connection with the foundations of the piers of the bridge under construction. There are also several small hand dredges of primitive construction employed by miners at various places along the river. not specially noted.

Dredges under construction.

All the dredges above referred to are dipper dredges of varying construction. On the south side of the river, at Edmonton, a large new dredge, the first of several which it is intended to build, was approaching completion. This belongs to the Saskatchewan Gold and Platinum Proprietory, (limited,) Mr. A. E. Hogue, general manager, and is in every way a great advance upon any dredge heretofore placed upon the river. It is to be provided with four engines, one to actuate an endless chain of buckets, one for the winches by means of which the dredge will be moved from place to place, and a couple to pump water to wash the gravel. It is intended to raise the gravel to a height of twenty-five feet above the deck, where, after the removal of the larger stones by a grizzly, it will be screened in revolving drums and the finer residue treated on blanket-covered Frue vanners placed on the after-part of the deck. This dredge was completed late in the autumn, but not in time to practically test it. Its working capacity is stated to be 3100 cubic yards of gravel in twenty-four hours.

Gold dredging in New Zealand.

The chief progress in river-dredging for gold, in late years, has been accomplished in New Zealand, where work of this kind has been carried out extensively, improved methods have been devised and an important industry established. An interesting synopsis of this work has recently been given by Mr. J. B. Jaquet, of the Geological Survey of New South Wales.*

Progress and improvements.

It appears that in New Zealand, spoon dredges, rigged on scows and operated by hand windlass, were first employed with some success

* Notes on gold dredging by J. B. Jaquet, Geological Survey of N.S.W. Government Printer, Sydney, 1898. Price 1s. 6d.

locally. Sand-pumps or suction-pumps were then tried, but, as in the western part of the United States, proved to be unsatisfactory. Steam bucket-dredges were then introduced and successfully worked. These soon superseded all others, and the tendency now is to build them of increasing size and capacity. Electric motors have also been employed with advantage. A great improvement was effected by the introduction of what is known as a tailing-elevator, which prevents the tailings from finding their way back into the excavation made by the buckets, and enables them to be stacked, from the stern of the dredge, where desired ; in the case of the larger dredges to a height of forty feet above the water-level. By means of this arrangement the dredges can work the low river-flats, cutting channels for themselves, and can even attack gravel banks twenty-five feet in height.

Saving the gold.

In saving the gold, various ingenious devices are employed, in regard to the details of which reference should be made to Mr. Jaquet's report. The greatest advance recorded is that of the introduction of revolving screens with water-jets.

Economy of working.

By perfected appliances of the kind above alluded to, extremely finely divided gold may be saved, actual experiments having shown that particles as minute as one-thousandth of a grain in weight are successfully collected. An instance is quoted showing profitable work in ground yielding only 1·35 to 1·41 grains ($5\frac{1}{2}$ to $5\frac{3}{4}$ cents) per cubic yard, and in Montana, the running cost of working gravels with steam power has been reduced to 9 cents per cubic yard, or with electric power, as low as $4\frac{1}{2}$ cents.

Favourable prospects on the Saskatchewan.

There appears to be no reason to doubt that satisfactory results, comparable with those achieved in a number of cases in New Zealand, may be obtained on several rivers in the North-west, and more particularly on the North Saskatchewan. Properly constructed dredges of adequate size and capacity will permit work to be carried on continuously during about half the year. It is to be remembered that such dredges enable the working not only of the bars and bed of the river, but also of the adjacent river-flats, where these do not possess a greater and more permanent value for agricultural occupation. Many of these flats are known to be underlain by auriferous gravels which have never yet been touched.

Annual yield of gold.

The approximate annual yield of gold from the North Saskatchewan, since 1887, is thus given in the report of the Mining and Statistical Section of the Survey for 1898. It must be borne in mind that very considerable amounts had been recovered in still earlier years, for which no figures are available ; also, that practically the whole of the yield stated up to the present time has been the result of hand work.

Value of Gold obtained from the North Saskatchewan River.

Year.	
1887	$ 2,100
1888	1,200
1889	20,000
1890	4,000
1891	5,500
1892	10,506
1893	9,640
1894	15,000
1895	50,000
1896	55,000
1897	50,000
	$222,946

Before leaving the subject of the auriferous drifts of this part of Alberta, occasion may be taken to allude to a couple of interesting finds lately made in connection with the old gravel deposit specifically named the Saskatchewan gravels. In 1895, I obtained from Mr. J. Gibbons, the tooth of a mammoth, which had been discovered in the workings carried on in these gravels some six miles above Edmonton. This is probably referable to *Elephas primigenius* or *Americanus.* A rather small but well preserved mammoth tusk was also seen by me at Edmonton last year. This was picked up on a river-bar near Goose Encampment, but from which of the beds in the river-banks it may have been derived is uncertain. Last autumn, from Mr. D. W. Macdonald, of Edmonton, portion of a skull was received which proved to be that of a musk-ox. This was from the roof of a drift, run into the bank for coal-mining purposes about a mile below Edmonton in which a fall had occurred in connection with the work. It, in all probability, was likewise derived from the Saskatchewan gravels, which here, with a variable depth, directly overlie the coal-bearing Laramie rocks. A preliminary examination of this somewhat imperfect specimen, develops no points of difference between it and the old adult skull of *Ovibos moschatus.* Although a long way south and west of the present range of the musk-ox, it is to be noted that two species of this animal have previously been described from Pleistocene beds in Kentucky and on the Arkansas River, which Flower and Lyddeker suggest may be referable to the existing form.*

Mammoth and musk-ox remains in the older gravels.

It is possible that the remains above noted from the Saskatchewan gravels, may have been derived from superficial deposits antedating

Date of these remains.

* Mammals Living and Extinct, p. 330.

these gravels and therefore of Pliocene age, but it is much more probable that the mammoth and musk-ox actually inhabited the region in the early Pleistocene, at a time when the mountains to the west were buried under the mass of the Cordilleran glacier.

Crow Nest Pass coal-field.

The following notes refer to the development of the Crow Nest Pass coal-field, now in progress.

Fernie Station, on the Crow Nest Pass Railway, is situated in the Elk River valley where Coal Creek enters this valley from the east. A range of 100 coking-ovens of approved type was in construction here at the time of my visit, early in September, and since then fifty of these ovens have been completed and the actual manufacture of coke has commenced by the Crow Nest Pass Coal Company (limited). Houses for the miners have also been constructed at Fernie and a town-site has been laid out. From Fernie, a spur line has been built up the valley of Coal Creek for about five miles, to the place at which the actual mining operations are in progress. Although bounded on both sides by mountains several thousand feet in height, the valley here opens out considerably, affording ample room for a large loading yard, as well as for the construction of the necessary bins, screens and other appliances for handling the coal. Work upon these appliances was actively in progress when seen.

Mining work in progress.

Here, under the immediate superintendence of Mr. W. Blakemore, the outcrops of the coal-seams have been uncovered and drifts have been run in on both the north and south sides of the valley. The beds here belong to the west side of the coal-basin and have an easterly dip at an angle of about twenty degrees. The principal seam opened on the north side of the valley, according to Mr. Blakemore, yields 5 feet 6 inches of workable coal, while that on the south side is about 6 feet thick. The relative stratigraphical position of these two seams has not been accurately determined, owing to landslides at the base of the mountain slopes, but it is believed that the seam on the south side (known as No. 2) is from 80 to 100 feet above the other, the intervening rocks being chiefly sandstones, but possibly, in accordance with Mr. Fernie's views, including a third and much thicker coal-seam. It is proposed to decide this point, at an early date, by further work.

Exploratory work on Michel Creek.

Exploratory work was also being carried out by Mr. Fernie in the valley of Michel Creek where followed by the main line of railway, about sixteen miles to the north-east. The coals here opened on, occupy positions considerably higher stratigraphically in the Kootanie series of the Cretaceous. A trial heading has here been run into a seam 13 feet thick, which is believed to represent the Peter seam,

openings upon the outcrop of which were made some years ago near Marten Creek, on the line of the old trail. This heading is about five miles west of the summit of the pass, or practically at the junction of the East Fork of Michel Creek with the main valley. Prospecting operations are also in progress in adjacent parts of the Michel valley on other beds of the fine series of coal-seams that characterized the Crow Nest basin. The great value of this remarkable field is, in fact, now in a fair way to be realized, and from this time onward continuous shipments of excellent coke will no doubt be made from it to the smelters and metalliferous mines of West and East Kootenay.

Shipments of coke.

The geological structure of the Rocky Mountain ranges proper, or that part of the western mountain region that lies between the eastern foot-hills and the great Columbia-Kootenay valley on the west, assumes a great practical importance in view of the opening up and working of the coal-beds included within its area. On the map accompanying my Preliminary Report on that portion of the Rocky Mountains between Latitudes 49° and 51° 30′, forming part of Volume I. (1885) of the new series of Annual Reports of the Geological Survey, the areas of the Cretaceous coal-bearing rocks are represented with approximate accuracy and in so far as the work carried out up to that date allowed. Several sectional diagrams were also given; but at the time the explorations to which this report relates were made, the existence of extensive "overthrust faults" as a factor in mountain structure had scarcely been recognized by geologists. At a later date, the importance of such faults was very strikingly demonstrated, particularly in connection with the geology of Scotland, and it was realized that by tangential pressure, acting on the earth's crust, older beds may be bodily thrust forward upon newer formations for distances measured in miles.

Geological structure of coal-fields.

Overthrust faults.

The position of the Cretaceous coal-bearing rocks at and within the eastern edge of the mountains on the Bow and Elbow rivers, appeared to indicate the existence of an overthrust of the kind, but it was not until Mr. R. G. McConnell made his detailed examination of the Bow Pass, in 1886, that it was actually possible to state that the Palæozoic rocks had, in that vicinity, along the eastern point of the mountains, been thrust forward over the Cretaceous beds and up a gently inclined fault-plane for a distance of about seven miles, by pressure acting from the westward. This feature, as demonstrated in the vicinity of the Bow, is clearly shown in the sections accompanying the report cited.*

First determined on Bow River.

* Annual Report, Geol. Surv. Can., vol. II. (N.S.), Part D.

Bearing on structure of Rocky Mountains.

It had heretofore been supposed that a great normal fault, with downthrow to the eastward, defined the eastern base of the Rocky Mountains in this vicinity and separated the rocks of the mountain region from the wholly Cretaceous and Laramie rocks of the foot-hills; but the structural discovery above alluded to, at once threw doubt on the earlier supposition, as well as upon several of the sketch-sections drawn in conformity with it in other parts of the mountains.

Application to Crow Nest field.

In the map above referred to, the approximate western boundary of the Crow Nest coal-basin is shown to closely follow the Elk River. Later, but as yet very incomplete observations, seem to indicate that a not inconsiderable width of the Cretaceous rocks may, in some places, occur to the west of that river, between it and the high mountain range which is evidently composed of Palæozoic limestones. It further appears to be, at least quite possible that the coal-bearing rocks may be found to pass beneath these older rocks by overthrust of the latter, and that another development of the coal-seams already known east of the Elk may be discovered there. It is obvious that if the coal-bearing formation could thus be shown to underlie the limestone range to the west of the Elk to any considerable extent, and to contain unbroken coal-seams of a workable character there, the area of this already very important coal-basin might prove to be, for practical purposes, materially greater than has been supposed.

Other possible lines of overthrust.

Further east on the Crow Nest Pass, is another similar line of possible overlap of the older rocks upon the newer coal-bearing Cretaceous, where these meet near the east end of the Crow Nest Lake. It is not, however, so likely that conditions of this kind occur where rocks of the same series come together at the eastern entrance to the pass, along the base of the Livingstone Range, as both the older and newer rocks here stand at very high angles, not suggestive of any extensive overthrust.

Practical bearings.

The questions thus stated, arising from the scientific study of the section met with on the Bow Pass, have obvious practical bearings in regard to the coal lands, and seem to call for examination and decision, by means of surveys more exact than have hitherto been feasible.

May explain occurrence of petroleum.

It further appears to be quite possible that overthrusts of the kind referred to may serve to explain the otherwise somewhat anomalous occurrence of petroleum in the southern part of the Rocky Mountains, between the Crow Nest and South Kootenay passes. The actual existence of small quantities of petroleum in several places in this portion of the mountains was verified, some years ago, by the personal

observations of Dr. Selwyn.* The petroleum was actually found in parts of the mountain region characterized at the surface by very ancient rocks, probably of Lower Cambrian age. If it may be assumed, however, that these rocks possibly overlie, in some places, those of the Cretaceous series, by reason of overthrusts, it is easily conceivable that the petroleum in question may have originated in consequence of heat, at considerable depths in the earth's crust, acting upon the fixed hydrocarbons contained in the rocks of that series.

Now that the completion of the Crow Nest Pass Railway has rendered it possible to transport boring appliances to the Flathead valley without great difficulty, it is likely that test wells will soon be sunk there. The indications certainly seem to be sufficiently promising to warrant some outlay in work of the kind, notwithstanding the generally disturbed and broken character of the formations of the region. Test borings suggested.

SYNOPSIS OF FIELD WORK.

In laying out the field-work for the past year, it was evident that special attention should be given to the Yukon District, and Mr. McConnell and Mr. Tyrrell were both consequently assigned to different parts of this district. Their reports are given on a later page. The number and distribution of parties in the field, engaged in work that occupied the greater part of the season, is given below :— Distribution of field-parties

British Columbia	1
Yukon District	2
Alberta (boring operations and collecting)	2
Ontario	4
Quebec	1
New Brunswick	2
Nova Scotia	3
Ungava (East coast of Hudson Bay)	1
	16

Dr. H. M. Ami and Mr. L. M. Lambe, both occupied in palæontological work, are here counted with the field parties.

Shorter periods were spent in field-work by Mr. J. White, who ran transit and chain lines from Ottawa to Sharbot Lake, and from Carleton Junction to Chalk River, thus completing a base-line, for geographical purposes, between Ottawa and Georgian Bay. Mr. Willimott

* Summary Report, 1891, p. 10 A.

also visited a number of localities in Quebec and Ontario for the purpose of obtaining specimens for collections and for the museum, and Professor J. A. Dresser of Richmond, Quebec, was afforded facilities for the prosecution of a petrographical examination of Shefford Mountain in the "Eastern Townships" of that province, from which it is anticipated that interesting results will follow.

Review of explorations in 1898.

The main features of the field-work accomplished during the year, may be epitomized briefly as follows, further details being contained in the reports handed in by the officers engaged in it and printed on later pages of this Summary. The reports are taken up, as usual, in order from west to east.

Yukon District west of Lewes River.

To Mr. J. B. Tyrrell was assigned the preliminary examination of a portion of the Yukon district, to the west of the line of the Lewes River and south of Fort Selkirk. Considerable difficulty was experienced in this work, on account of the failure of the horses depended upon for transport, but about 300 miles of new surveys were made and geological and other facts noted respecting the vicinity of the Dalton trail which had previously been mapped by Mr. McArthur of the Dominion Lands Survey. Mr. Tyrrell also joins with Mr. McConnell in a short report, giving the result of their united observations on the actual mode of occurrence and methods of working the gold placers of the Klondike region.

East of Lewes River.

To Mr. R. G. McConnell was entrusted the task of making a geological reconnaissance and exploration of part of the Yukon district to the east of the Lewes and south of the latitude of Fort Selkirk, together with the line of route from Teslin Lake to the Stikine River, in the northern part of British Columbia. He was also requested to make, if possible, a preliminary study of the mode of occurrence of gold in the Klondike region itself, where such important mining operations are already in progress. In the course of these operations the Big Salmon and Nisutlin rivers were ascended to their sources, and surveyed wherever necessary, and Teslin River and the borders of Teslin Lake were examined. The results indicate the existence of several new tracts of country which appear to warrant close examination on the part of prospectors, besides affording approximate outlines for the geological formations over a large region in which these had previously remained unknown.

Edmonton to Yellow Head Pass.

A general reconnaissance survey has been made by Mr. J. McEvoy, from Edmonton westward to the upper waters of the Fraser and Canoe rivers, with special reference to that part of the Rocky Mountains in this vicinity. Practically all the geological information heretofore

available for this region was that gained by Sir James Hector, many years ago, under the unfavourable circumstances of rapid winter travel. The knowledge since obtained of the general structure of the mountains, both to the south and north, renders it comparatively easy to understand that of the intermediate district, and the facts observed by Mr. McEvoy will enable what has been a considerable gap in all previous maps, to be filled with approximate accuracy. Notes were also obtained respecting prospecting and mining operations in the district, the character of the various routes, forests, agricultural value of the lands, etc. A notable point is the approximate determination of the height of Robson Peak, which, as stated on a subsequent page, appears to be the highest submit in the Canadian Rocky Mountains.

West Kootenay.

In West Kootenay, the mapping work referred to in previous reports was continued and extended by Mr. R. W. Brock and Mr. W. W. Leach. The laying down of the topographical features of this exceptionally rugged mountainous district, is here a necessary adjunct to the geological mapping, and the smoke from forest fires seriously impeded this work by interfering with the utility of the various transit stations. Substantial progress was, however, made in the work. The area to which particular attention was given, being between Slocan and Lower Arrow lakes, is almost entirely mountainous, culminating in the ragged crests of the Valhalla Range. The rocks met with are chiefly granites, referable to several periods; and in regard to their relations and those of the contained areas of altered sedimentary rocks and later dykes, some valuable information, bearing directly upon the mode of occurrence of the ore-deposits of the district, was obtained. Further evidence was also noted, at heights between 7000 and 8000 feet of the passage of the great Cordilleran glacier over the entire district in a south-easterly direction.

Western Ontario.

Surveys of the gold-bearing region of Western Ontario were continued by Mr. W. McInnes, and directed to the completion of a new map-sheet to the north of that known as the Seine River sheet, and east of the Manitou sheet, now in course of compilation. These surveys necessarily involve the mapping of the lakes and rivers of the region to be covered, and although good progress has been made in the work, it will be necessary to devote another season to the area in question before it can be definitely laid down and completed for publication. It has already been pointed out on several occasions, that the work of the trained geologists of this Survey would be carried on to much greater advantage and with less delay, if the geographical outlines were in advance laid down by the provincial authorities. This is especially to be desired where, as in the region here parti-

Assistance in surveys required.

cularly referred to, prospectors and miners are urgently requiring geological maps for their guidance.

Lake Nipigon. In order to complete the work necessary for the compilation of a general geological map of Lake Nipigon, north of Lake Superior, Mr. D. B. Dowling was engaged in surveys on that lake and in its vicinity. The outlines of the Nipigon and Huronian rocks were defined and the numerous large islands were laid down, some of them for the first time.

Michipicoten. In the Michipicoten region, about the north-east coast of Lake Superior, Dr. R. Bell was employed, during several months, in ascertaining the boundaries and character of the Huronian rocks and other features of the geology, the recent discovery of gold in the district having rendered this particularly desirable. The distribution of the Huronian—here as elsewhere the gold-bearing series—had previously been but imperfectly determined, and the additional information now gained should be of importance in guiding the future work of prospectors and miners.

Central Ontario. In Central Ontario, detailed geological work has been continued on the Haliburton map-sheet by Mr. A. E. Barlow and Dr. F. D. Adams, with a view to making this a typical sheet for the entire region, and also for the purpose of determining, as far as possible, important questions bearing on the relations and mode of mapping the Grenville, Hastings and Huronian formations. This investigation is now well advanced, but definite statements respecting its results are deferred pending its completion. The occurrence of certain remarkable conglomerates met with, has been found to depend on the internal movements of masses composing them, and some of the highly crystalline limestones, have been traced continuously into beds of limestone but little altered. Several additional areas of nepheline-syenite have also been discovered, and these obtain some economic importance because of the association of corundum and muscovite mica with them.

Three Rivers map-sheet. A part of the season of field-work was employed by Dr. R. W. Ells, in obtaining some additional details that proved to be required for the Perth and Ottawa City map-sheets of the Ontario series, and in visiting some localities within these sheets where minerals of economic value had been reported. The greater portion of his time was, however, given to further examinations in the area of the Three Rivers map-sheet in Quebec, now in the hands of the engraver. The general character of the crystalline rocks of this region, has already been described, but the work now done, in conjunction with that previously accomplished by other members of the staff, has enabled Dr. Ells to prepare a short descriptive report for publication with the map-sheet.

Explorations in Hudson Bay.

Mr. A. P. Low was entrusted with the task of continuing and completing the exploration and survey of the eastern coast of the northern part of Hudson Bay, together with that of the northern islands in the Bay. It appeared to be necessary for the proper prosecution of this work that the available seasons of both 1898 and 1899 should be employed in it, arrangements being made to pass the present winter on the shore of Hudson Bay. The small yacht employed by Mr. Low in Hudson Strait in 1897, had been stored at Nachvak on the Labrador coast. He therefore left Quebec in the Hudson's Bay Company's schooner for Rigolet, on the Labrador coast, on June 30th. At Rigolet he was picked up by the steamer *Erik* belonging to the same company, on her arrival from England, and taking the yacht on board at Nachvak, he proceeded through Hudson Strait, leaving the steamer in a bay east of Cape Wostenholme. A letter written at that time, under date 30th July, is the latest information received in regard to this expedition. Early in the season an ample supply of provisions for the winter was despatched via Missinaibi and Moose River, in charge of the Hudson's Bay Company for transportation to their post at the mouth of Great Whale River, where Mr. Low intended to winter. From this place it is also intended that he should carry out such exploratory trips inland as may be found possible, during the winter and spring. A short report has since been received from Mr. Low which will be found on a later page.

New Brunswick.

The mapping of the surface geology of New Brunswick, was resumed last summer by Mr. Chalmers, in portions of York, Sunbury and Carleton counties, and in connection with this several interesting facts relating to the St. John River and valley were noted. Professor Bailey was also employed in New Brunswick in obtaining further notes on economic minerals and in investigating the age of the great slaty band of the interior of the province. Some new facts relating to the coal measures of New Brunswick, which have come under his observation, will be made the subject of a future report.

Nova Scotia.

In Nova Scotia, Mr. Fletcher has been engaged during the season chiefly in the vicinity of the Springhill coal-field. The principal result of this work, and one having great economic importance, is the tracing out of the coal seams upon which mining is now in progress, for a distance of more than two miles further than these were previously known to extend. Mr. Faribault also continued his work in this province, the greater part of his time being devoted to the gold-bearing districts east of Halifax, upon which he has a special report now in course of preparation, On a later page of this Report

preliminary details are given bearing on the Waverly, Montague, Lawrencetown, Lake Catcha, Tangier and Cow Bay gold districts.

Experimental Borings in Northern Alberta.

Boring operations in Alberta.

The second and third of the experimental borings in search of petroleum in the northern part of Alberta, were begun early in the summer of 1897 near the mouth of Pelican River, on the Athabasca, and at Victoria, on the Saskatchewan, below Edmonton, respectively. The sites selected for these borings were deteimined largely by the knowledge of the stratigraphical succession and thickness already gained in the first bore-hole at Athabasca Landing. The borings at Pelican and Victoria had reached depths of 820 and 705 feet respectively before winter. Operations were resumed at both places in the spring of 1898, as soon as the requisite arrangements could be made.

It will be remembered that work had to be suspended at Pelican in 1897, because of a very heavy flow of natural gas, under great pressure. It was hoped that most of this gas might blow off during the winter, and it was in fact found to be considerably reduced in amount when the locality was again reached by Mr. Fraser in 1898. Work was resumed, but additional and very strong flows of gas were soon met with in the underlying beds, and after exhausting every method of mastering these and continuing the boring, it became necessary again to suspend operations.

Difficulties met with at Pelican.

Some particulars of the attempts here made are given below in Mr. Fraser's report, from which it appears that the practically insuperable obstacle met with, was the clotting of the casing and tools with the heavy tarry petroleum, or maltha, mixed with sand, which was thrown up by the discharge of gas. It had been hoped that, at a greater depth, and particularly in the Devonian limestones from which the oil has been originally derived, it might be found in a more fluid state, but it has proved to be impossible to penetrate the "tar-sands" at the base of the Cretaceous at this place, and it appears probable that this could only be accomplished by beginning at the surface with a hole of much larger diameter.

Progress at Victoria.

Meanwhile, the boring operations at Victoria were steadily continued, without notable incident, but progressing slowly in depth on account of the exceptionally difficult character of the crumbling clay-shales to be penetrated. When the circumstances rendered it advisable to close the work here for the season, the depth obtained was 1650 feet. The hole is cased to this depth with $4\frac{5}{8}$-inch casing, and is in good condition for the resumption of work in the spring, when it

will be necessary to introduce $3\frac{5}{8}$-inch casing, a sufficient quantity of which has been delivered at Edmonton.

Temperature in boring.

At 1600 feet, the temperature in the bore-hole was found to be 76° F., as determined by special maximum thermometer manufactured by Casella.

It is believed that it will be necessary to carry this boring down to a depth of about 2000 feet, in order to make a fully satisfactory test of the rocks to the base of the Cretaceous in this place. The work so far has been confined to penetrating the great mass of overlying shaly rocks of this formation that it was known would be found here, and in which no developments of economic importance were anticipated.

Visit made to Big Egg Lake.

At the request of several gentlemen in Edmonton, I visited Big Egg Lake, about twenty-five miles north-west of Edmonton, on August 22nd, in company with Mr. W. A. Fraser and Mr. E. Lyons, for the purpose of examining the indications of petroleum which had been found there. The place had already been examined by Mr. J. B. Tyrrell and by Dr. A. R. C. Selwyn, in 1893 and 1894 respectively, but it seemed possible that the facts since ascertained by means of the experimental borings might throw some further light on the conditions at Egg Lake. Tarry or pitchy matter is stated to have been here first found in ploughing on the north-west quarter of section 30, township 56, range XXV., west of the 4th meridian. Several small excavations were then made, and veins or layers of hardened pitch and pitch-saturated sand were found. The pits had, however, become filled before the time of my visit, and nothing could be seen but lumps of pitchy material which had been thrown up in digging them.

Previous observations by Mr. Tyrrell

When Mr. Tyrrell visited the place the pits were still open, and as his report on observations then made was not published, the following may be quoted from it:—

"On an almost level plain, declining very gently towards Egg Lake, several pits had been dug from three to four feet deep and in all 200 yards apart in a north-and-south line. On the side of the most northern pit, a narrow vertical vein of rather hard pitch, in places about an inch wide, could be seen running through the clay. Another pit, fifty feet south of the last, had been dug to a depth of nine feet six inches, but at the time had six feet of water in it. A large amount of sand saturated with tar was lying beside this pit. We baled the water out of this pit, when the unstratified material with pebbles was found to extend down to a depth of eight feet, and through it were running many veins of hardened pitch. Below this, a coarse, moderately even-grained and apparently horizontally bedded sand is reached. This sand is saturated with tar."

Search for oil.

Subsequent to the date of Mr. Tyrrell's note, a boring to a depth of 120 feet was made, about 150 yards to the north-eastward of the pit last described, by Mr. W. Pearce, who states that after passing through eight feet of soil and clay he found eight inches of tarry sand; after which he appears to have penetrated boulder-clay to a depth of forty feet, then layers of sand and gravel with water and below this soft sandstones of the Laramie formation.

Indications of a line of fault.

About three-quarters of a mile distant from the field in which the pits were sunk, on the south-west quarter of section 31, in the same township, is a rather remarkable spring and mire-hole. The outflow is not copious, but is accompanied by the emission of sulphureted hydrogen. Another spring of the same kind, and slightly saline, occurs about half-way between the first and the place where the tarry matter was found, and all three localities lie in a nearly due north-and-south line. The circumstances are in fact such as to favour the belief that the underlying strata have here been cut through by a small fault, by means of which the waters of these springs, and at an earlier date, the tarry matter, have forced their way to the surface.

Deductions from observations.

If this supposition be correct, it would follow that the petroleum from the deeper beds of the Cretaceous must have been in a sufficiently fluid state to rise through a fissure of the kind and locally saturate beds of sand traversed by it, as well as to fill narrow veins in the boulder-clay, subsequent to the glacial period; and it would appear probable that, in this part of the region at least, it may still remain in a similar condition. It does not follow, however, that this would be a specially favourable locality in which to test the lower beds of the Cretaceous by boring, for, on the contrary, our knowledge of the geological structure of this part of the country indicates that the depth at which these beds lie is here very great, probably at least 2500 feet and possibly much more.

Objects and progress of boring operations.

The experimental boring operations were initiated with the object of seeking for petroleum in quantities of commercial importance, at localities not too far removed from settlements and means of communication. The indications of the existence of petroleum, in the form of enormous deposits of "tar-sands" appearing along the natural outcrop of the lowest Cretaceous beds of the region, on the Athabasca, fully warranted the experiments entered on. The actual boring operations, have, in consequence of many unforeseen difficulties met with and the time lost in consequence of the remoteness of the work, been attended by regrettable delays, and have so far failed to demonstrate the existence of petroleum of economic value in respect to quality and quantity. They have, however, as pointed out in previous reports,

demonstrated the regularity and the great extent of the probably oil-bearing beds, and have indicated the occurrence of natural gas in important amount over a large tract of the North-west.

Petroleum of commercial value not yet discovered.

In regard to the actual existence of petroleum, the results have not up to the present stage been so satisfactory. The boring first begun, at Athabasca Landing, was unavoidably abandoned at a depth of 1770 feet, without reaching the probably oil-bearing beds at the base of the Cretaceous formation, but within a short distance of attaining these beds. The boring near the mouth of the Pelican River, penetrated the lower sandy beds of the Cretaceous for some distance and demonstrated the existence in these beds of a thick tarry petroleum or maltha, besides that of great reservoirs of natural gas. It has proved impossible to carry this boring to the very base of the Cretaceous and into the underlying formation, in which the existence of a more fluid and merchantable oil was still to be hoped for. The appearance of maltha at a distance of some sixty miles behind the natural outcrop of the "tar-sands" and where these basal beds of the Cretaceous are so well under cover, at a depth of 800 feet, is, it must be confessed, somewhat disappointing. It may possibly be that all the petroleum, derived from the underlying Devonian rocks, has, after saturating the porous beds at the base of the Cretaceous, passed into this tarry condition; but this is by no means probable, and the facts already described as seen at Egg Lake, appear to show that at a very late period, geologically considered, petroleum in a liquid form has existed, locally at least, in the underlying rocks.

Great area which may yield petroleum.

Taking the proved existence of tarry petroleum at the Pelican and the indications at Egg Lake together, we appear to have a demonstration of the occurrence of such hydrocarbons for a distance of over 150 miles from, and nearly at right angles to the direction of the natural outcrops of the "tar-sands" on the lower Athabasca. The locality at which the first experiment was attempted, Athabasca Landing, lies nearly in a line with these occurrences and not far from midway between the Pelican and Egg Lake, with the advantage over the latter of a much less depth of strata to be penetrated in order to pass through the whole thickness of the Cretaceous. The boring now in progress at Victoria, lies about fifty miles to the east of the line above referred to. This boring is in good condition for prosecution to the required depth next summer, and it is believed that it should be continued and completed. It is also believed that, in further prosecuting the work, a new boring should be undertaken at Athabasca Landing, beginning with a diameter somewhat greater than the last. With the experience now gained of the character of the shales to be penetrated,

Future operations.

it should not be difficult to carry the boring to the required depth without much loss of time.

Should the borings at Victoria and at Athabasca Landing find only maltha in the lower porous beds of the Cretaceous, and should the underlying Devonian rocks, to a moderate further depth not yield a liquid oil, it would be necessary to admit that the probabilities of developing petroleum of commercial importance in this part of Alberta are small. So far, however, the only discouraging feature met with is the appearance of tarry oil at the Pelican, while the proved continuity over a great area of the oil-bearing conditions, is most important, and the outlook generally is such as to be well worth any further effort that may be necessary to fully test the matter.

Report by W. A. Fraser.

The following account of the actual progress of the boring work is from Mr. Fraser's report on the same.—

" Both the bores commenced during the season of 1897 had been left uncompleted at the end of that season. The bore at Victoria had been carried down to a depth of 705 feet, and was discontinued in the autumn at that depth, being still in the dark shales which overlie the other strata, and which have a thickness of a thousand feet or more.

Boring near Pelican River, Athabasca River.

Pelican boring stopped by gas.

" The bore at Pelican River had been stopped at 820 feet owing to the striking of an immense flow of gas, which made it impossible to work while it continued to flow with such force. It was thought that by the spring of 1898 it would have exhausted itself sufficiently to permit further boring, and to this end the casing, $4\frac{5}{8}$-inches in diameter, was left quite free and open to permit the escape of the gas. It was estimated that before a depth of 1000 feet was encountered the Devonian limestone would be pierced.

Resumption of work.

" Upon investigation in the early part of the present season, the flow of gas seemed to have very materially decreased; but upon operations being resumed, the seeming decrease was found to be in a great measure due to the closing up of the outlet at the bottom part of the casing by an asphalt-like mixture, composed of maltha, or petroleum tar, and sand. In fact, when boring operations were resumed on June 17th, the difficulty was found to be intensified by the accumulation of this asphalt-like maltha in the bottom of the bore.

Difficulties met with.

" The rapid expansion of the gas produced a very low temperature, and this chilled and solidified the tar, or maltha, until it became as

adhesive as wax. As the tools cut it loose the gas would carry it up through the bore, until from bottom to top, it was almost one mass of sand and tar. The only way it could be extracted from the sand-pump was by heating the latter over a fire; even then very little could be got out at one time, it being so thick that it was almost impossible to force it up into the pump. I used different sorts of tools to cut it off the walls and clean it out, but the longer we worked at the bore the greater the quantity of tar accumulating on the sides of the casing and tools.

"We then pulled the $4\frac{5}{8}$-inch casing out, thinking we might be able to ream down past the flow of gas, and thus shut it off, but the gas, which had increased in power with the cleaning of the hole, cut the walls down and blew great clouds of sand and gravel higher than the derrick. The men were forced to put the $4\frac{5}{8}$-inch casing back in the hole without being able to ream past the strata from which the gas came. Great force of gas.

"While this was being done, I proceeded to Athabasca Landing, and sent down to the works by boat 1050 feet of $3\frac{5}{8}$-inch casing. I then continued on to Edmonton to get a patent 4-inch drill bit which I had ordered by telegraph from Petrolia.

"After putting back the $4\frac{5}{8}$-inch casing, the driller succeeded in getting the bore down seven feet below the formation from which the gas came. This filled in with maltha, and when they put down the $3\frac{5}{8}$-inch casing to the bottom, it being wedged tightly in this maltha, shut off the flow of gas from the inside of this casing. The gas was then escaping between the $3\frac{5}{8}$ and $4\frac{5}{8}$ inch casing. Further depth obtained.

"Owing to the shutting off of the gas, it became possible to get water down inside the $3\frac{5}{8}$-inch casing, and the men drilled ten feet very fast, through a soft sandstone. At this depth, 830 feet, another small flow of gas was encountered, but by using a casing-head, and a short piece of 1-inch pipe, they still managed to get water down inside the $3\frac{5}{8}$ inch casing to drill with. In this manner another seven feet was drilled, when a strong flow of gas and maltha was struck in a conglomerate formation. This flow of gas, at 837 feet, was nearly as strong in volume as that met with at 820 feet.

"The $3\frac{5}{8}$-inch casing could be carried no deeper, owing to the strength of the gas and the impossibility of getting water down, and as a smaller size of casing could not be used, nothing remained but to wire to Ottawa the condition of affairs, and wait for instructions. Upon receipt of your instructions to suspend operations, I did so at once, and returned the men to Petrolia. Drilling stopped by outburst of gas.

Character of the gas.

"I proved the general excellence and utility of the gas during the season, using it for my boiler, cook-stove and for lighting. I had only a 1-inch pipe, tapped into the side of the casing, and probably did not use the one-hundredth part of the gas coming from the bore, but there was sufficient to make all the steam necessary on my twenty-five horse-power boiler, keep fire in the stove, and also to supply a strong flare-light. The gas burned beautifully clean.

Its force.

"In working at the bore, the screeching and hissing of the gas, when at all confined by the presence of the tools inside the casing, or from other causes, was so great that the men complained of pains in their ears and heads.

"All that could be done was done to get the bore down the couple of hundred feet necessary to make a complete test in this place, and though failure was the result, it has, perhaps, shown how a bore may be carried down so as to get through these extraordinary gas veins. To ensure success, a new bore at the depth of 820 feet, where the first large gas-vein was encountered, should be at least ten inches in diameter; then it would be possible to reduce the casing four or five times, giving that many different lines of pipe to be used in getting by these gas-veins.

Extent of gas-field proved.

"The bore also furnishes additional evidence of the existence in the North-west Territories of a vast gas-field. The seemingly uniform continuity of the Cretaceous beds, makes it almost certain that gas-wells may be obtained by boring, over a great area, as pointed out in the Summary Report of the Geological Survey for last year, (pp. 18-19). Unfortunately the Pelican bore, like the boring at Athabasca Landing, did not penetrate deep enough to furnish reliable information as to the existence, or non-existence, of petroleum of a high quality. The presence of the low quality petroleum—maltha—is demonstrated, but as the more liquid oil may very probably underlie this, and as we did not reach a sufficient depth to determine the point, the result is unsatisfactory.

Section.

"The formation, from 820 to 837 feet, is a continuation of the "tar-sands" as under:—

820–830	feet.	Soft sandstone.
830	"	Hard streak and light flow of gas.
830–836	"	Soft sandstone.
837	"	(Conglomerate) — Iron-pyrites nodules embedded in cement-like sandstone. Very strong flow of gas.

"Upon closing down the work, the rig, derrick, and all machinery were left standing in place, and the casing was left in the bore-hole.

Boring at Victoria.

"It was decided, in the latter part of the winter, to take to Edmonton only the gang of men intended for Victoria, leaving the bringing up of a gang for the Pelican boring until such time as the said boring might be inspected and the utility of further operations decided upon. So, early in May, I proceeded to Edmonton with a drilling gang for the boring at Victoria. We reached Edmonton on May 7th, and proceeded to commence work at Victoria at once.

Boring at Victoria.

"The $6\frac{5}{8}$-inch casing had been put down previously to a depth of 700 feet. It was impossible to drive it beyond that depth owing to the great pressure of the caving shale, consequently the $5\frac{5}{8}$-inch casing was inserted, and the bore continued of this diameter. Drilling was slow, owing to the continuous caving of these soft, dark shales, which correspond to the La Biche shales of the Athabasca bore.

Casing reduced in size with depth.

"The $5\frac{5}{8}$-inch casing was carried down to a depth of 1012 feet, when it became fast owing to the great pressure. Then the $4\frac{5}{8}$-inch casing was inserted and carried down to the present depth of the bore, 1650 feet.

"It was thought, judging from the progress this latter size was making, that it would be possible to continue it to probably 2000 feet, but at the above depth it rather suddenly ceased going, and I am of opinion that one of the small, hard, concretionary nodules, that we encountered from time to time, dropped in beside it, and wedged it over against the wall.

Casing stopped at 1650 feet.

"The pressure of the caved walls was so great on the casing that it was impossible to pull it up, otherwise we might have succeeded in clearing it. A patent under-reaming bit was used during the whole of the boring from 705 feet to 1650 feet, and gave good results.

"The continual caving of the shales made the drilling very slow, it being impossible at any time to drill more than ten or fifteen feet ahead of the casing. Saline water was encountered and also small flows of gas. At the present depth, there is a fairly strong gas-vein.

"Very little of unusual interest occurred during the season's work at Victoria. The driller I had, Mr. Wm. Slack, of Petrolia, proved a most careful, faithful and efficient man. This relieved me of a great deal of responsibility, and enabled me to devote more time to the operations at Pelican River.

"During the summer, it was decided that it would be advisable to have on hand at least 2400 feet of $3\frac{5}{8}$-inch casing, to carry on the boring in case the $4\frac{5}{8}$-inch should cease going. This was ordered, and

Smaller sized casing procured.

is now at Edmonton, ready to be sent down to Victoria for use in the bore during next season's operations. The 3⅝-inch drill tools which were at the Pelican River boring were also brought up, and are now at Edmonton."

Strata bored through.

Subjoined is a record of strata bored through at Victoria:—

705– 960	feet.	Soft dark shale.
960– 970	"	" " with layers of sand and a little gas.
970–1000	"	" "
1000– 20	"	" " streaks of sandstone.
102 – 30	"	Dark shale. Gas.
1030– 90	"	" Increased gas.
1090–1230	"	Soft black shale.
1230– 50	"	" " streaks of sandstone.
1250–1320	"	" " caving badly.
1320– 40	"	Brown shale, with sandstone layers
1340– 90	"	Sort dark shale.
1390–1410	"	Bluish shale. Thin streaks of sandstone.
1410– 28	"	Black shale.
1428– 30	"	Hard sandstone.
1430– 60	"	Black shale.
1460–1500	"	Bluish shale.
1500– 65	"	" Streaks of sandstone with gas
1565– 75	"	Hard sandstone.
1575– 85	'	Dark shale mixed with sandstone.
1585–1600	"	Hard sandstone.
1600– 45	"	Shale and sandstone strata mixed.
1645– 50	"	Hard sandstone.

Yukon District.

(With adjacent parts of British Columbia.)

Work by Mr. J. B. Tyrrell.

During the winter of 1897-98, Mr. J. B. Tyrrell was at first engaged in labelling and arranging the specimens collected during the preceding summer. Afterwards his time was devoted to examining and correlating the large series of Archæan rocks collected on Lake Winnipeg and in its vicinity during the summers of 1890, 1891 and 1895; to collecting the material for a final report on the Lake Winnipeg district, and to writing part of the report.

In the spring, he was instructed to undertake a reconnaissance survey of the south-western portion of the Yukon District, and with regard to this work he reports as follows:—

"On the 9th of May I received from you instructions for the season's work in the field, of which the material part was as follows:—

"'The principal object of your exploration will be to obtain as much geological and general information as possible respecting that part of the Yukon district between the line of the Lewes River and the 141st meridian, and to the south of the latitude of Fort Selkirk. The so-called Dalton trail will probably prove to be your most convenient base of operations, more particularly as it has already been mapped with some accuracy by Mr. McArthur of the Dominion Lands Survey.

His instructions.

"'Should good geological sections be met with, it may be well to devote some time to their particular examination, but, generally speaking, the work will require to be of a reconnaissance character, with the main purpose of ascertaining in what parts of the region the formations and conditions are such as to encourage search for payable gold deposits, ores and coal. Information of this nature will undoubtedly possess great value in directing the operations of prospectors in the season of 1899, by which time entrance to the entire Yukon District will probably have become comparatively easy.

"'The glacial and other superficial deposits will not escape your attention as these are likely to have intimate relations to the occurrence of placer gold.

"'If found to be convenient, at some time during the season it might be advisable to pay a brief visit to the Klondike region, for the purpose of comparing conditions there with those in the region more particularly under examination; but it would be unwise to allow this to materially interrupt the main work, in view of the shortness of the season, the necessary cost of the outfit for the expedition, and the probability that the horses, etc., may not be available for further operations in a following year. The same circumstances will render it proper to continue work in the autumn as late as the conditions remain reasonably favourable.'

"Mr. J. J. McArthur, D.L.S., of the Topographical Branch of the Department of the Interior, had travelled over part of the Dalton trail last year, and was going over it again this year on his way to Stewart River. He kindly offered to purchase horses for me and to take them to Pyramid Harbour with his own; as he was acquainted with the district, and where feed, if any, could be obtained, this was a favour which would assist me very materially at the beginning of the exploration.

Assistance from Mr. McArthur.

"Mr. J. F. Shaw, of Ottawa, was employed to look after the horses, and on the 26th of April I sent him west to join Mr. McArthur in Van-

Preparations for work.

couver, with instructions to render any assistance in his power in the purchase and care of the horses. On the 12th of May I left Ottawa and proceeded to Kamloops, where I obtained some saddles and blankets belonging to the Survey that had been stored there some years before.

"Thence I went to Vernon, and there employed two men, Cameron and Redmond, the former as packer, and the latter as cook. With these men I went to Vancouver, where I found that Mr. McArthur had gone on with the horses on the steamer *Islander* a few days before. After obtaining the supplies necessary for the summer, we followed in the steamer *City of Seattle*, and on 28th May arrived at Mr. McArthur's camp on the bank of the Chilkat River, not far from Haines Mission. As yet the grass had scarcely began to grow, and the country afforded very little feed for the horses, so that it was necessary to supply them with feed brought from the south. Dalton's new trail was not yet cut out on the west side of the river, and the flats by the river were so wet that they were scarcely passable.

Assistance from Mounted Police.

"Mr. McArthur obligingly agreed to continue in charge of both parties until the 12th of June, during which time he was able to move about twenty-five miles up the Chilkat River to the crossing of Salmon River. From here he was obliged to return to Dyea, while I pushed on to the camp of the North-west Mounted Police at Pleasant Camp, and then over the summit to Rainy Hollow, being the first to reach there with horses this summer. At the Mounted Police station, Inspector Jarvis kindly had all our horses shod, for many of them had dropped their shoes among the stones in the beds of the streams that had been followed or crossed. Our party, on leaving Pleasant Camp, consisted of myself, three men, and fourteen horses. On account of the scarcity of food the horses had failed in flesh very considerably.

"The Summit."

"The hill just west of Pleasant Camp, forming the high land known as 'The Summit,' is a spur of gray hornblende-granite projecting out into the valley. It is 1700 feet in height and rises with a slope of 22° from a small grassy plain surrounded by dense coniferous forest, to a barren alpine plateau, entirely devoid of trees. The luxuriant flora of the Pacific Slope extends up the Klaehini valley to this hill, and to some extent around it, and up the valley to Rainy Hollow, but beyond that point the flora of the drier interior plateau takes its place.

Dalton post.

"We continued on to Dalton post, on the Tatshenshini River, where we arrived on June 24th. The Indians of the surrounding country were collected in the adjacent village of Wesketahin to await the arrival of the salmon up the stream.

"On the way, I had made as careful an examination as possible of the general geology of the region, but since the sides of the wide valley were covered with glacial detritus up to height of from two to three thousand feet, it often required the expenditure of a great amount of time to see the underlying rock at all. As a general rule, however, the valley was found to run between a range of granite mountains to the north-east, and a range of mountains of schist, quartzite, etc., to the south-west. Rocks.

"The main branch of the valley, which we had been following, continues on towards the north-west from Dalton post, but we turned northward up the valley of Unahini River, and followed the banks of this stream, or climbed along the slopes of the mountains, to Klukshu Lake. Here a trail turns westward towards Shorty, Roberts and Alder creeks, but the Dalton trail, which we were following, continued northward, up the east side of the lake, and then across the wide Shakwak valley, through which Messrs. Glave and Dalton first reached this country in 1890. Lake Dezadash lies in the angle where the two valleys cross, and from it flows one of the longest branches of the Alsek, at first northward, then westward and afterwards southward to the Pacific. After leaving Lake Dezadash it flows through a deep and comparatively narrow valley, between Mount Kelvin, a magnificent granite mass that rises to a height of 5000 feet above the river on the east, and Mount Bratnober, about a thousand feet lower, on the west; this latter mountain appearing to be composed chiefly of dark mica-schists. Near Hutshi, the sources of the Nordenskiöld River, one of the tributaries of the Yukon, were reached. Up to this time no attempt at a survey had been made, but at Mr. McArthur's request I had taken a few observations for latitude. Continuation of Dalton trail.

"At Hutshi I began a compass and paced survey of the trail down the Nordenskiöld River, and continued this survey down to the Lewes River, where we arrived on July 12th.

"Although the greatest possible care had been taken of the horses they were now very much run down. I therefore left them here in charge of the men and in good pasture, and descended the river to Dawson, where I arrived on the 16th of July. Mr. McConnell, of this Department, had arrived there the day before, and together we examined Bonanza, Eldorado and part of Dominion creeks. Our report on this work is given on another page. Visit made to Dawson.

"On the 7th of August, I again reached my camp at the mouth of the Nordenskiöld River, but unfortunately some inflammatory disease had broken out among all the horses there, Mr. Dalton's as well as mine, Rejoin the party.

and instead of being in good condition for the work of the rest of the season they were lean and weak.

"At Dawson Mr. S. N. C. Treadgold, who was visiting the country in the capacity of a special correspondent of the *Mining Journal*, offered to accompany me for the rest of the season, and being rather short of men I was glad to avail myself of his services.

Travel westward.

"Acting on a suggestion made by Mr. McArthur, we returned up the Nordenskiöld River for a short distance, and then turned westward up the west branch of that stream, for which I would suggest the name Wright River, after Professor R. Ramsay Wright of Toronto University. We ascended the valley of this stream for most of its length, and then turned south-westward, through a ridge of rounded granite mountains, to a valley in which is a stream flowing towards the west. This valley was descended to the point where it is crossed by a trail from Hutshi to Fort Selkirk, and here the stream was recognized as that which had been called the Tahté by Mr. McArthur. We then travelled south to the Indian village of Aishihik, hoping to meet some Indians who would indicate to us the most feasible route into the country further west, but the place was found to be entirely deserted, so that we were thrown back on our own resources.

Trail by Tahté River.

"Finding a foot-trail leading to the west, we decided to follow it. It led us into a mountainous country underlain by mica-schist, limestone, etc. The second day we came to a creek flowing westward, but after following it, it turned to the north, and three days afterwards brought us to a wide valley which was evidently that of the Tahté River, and not far from the place where we had left that river a week before.

Reach White River valley.

"We descended this magnificent wide valley, which has finely terraced sides, for five days, until we found it opening out into the valley of White River. We thus found that the stream which we had been following was the Nisling River, which had been crossed by Dr. Hayes in 1889, on his overland journey from Fort Selkirk to the Copper River.

Return journey.

"It was now the 29th of August, and a hard frost on the night of the 27th had begun to strip the leaves from the poplars, warning us that the summer was over, and that the Chilkat Mountains, near the coast, would soon be covered with snow. We therefore turned back up the Nisling River, followed it up to the crossing of the Selkirk trail, and then followed that trail southward to Aishihik. From Aishihik we followed the high ridge west of Aishihik Lake, crossed the Aishihik River, and reached the west side of Hutshi Lake, just as Mr. Hanley camped on its eastern side with a large band of horses.

"The next morning, Sept. 12, we came up with Mr. Hanley, and as most of the horses that we had left were about used up, we hired three fresh ones to help us out to Pyramid Harbour. On September 17th, we reached Dalton post, and on the 21st the post of the North-west Mounted Police at Pleasant Camp. Besides the horses that we had hired from Mr. Hanley, there were six of our own remaining. We had spared them all summer as much as possible, by carrying just what was absolutely necessary for the work in hand, and by walking almost all the time ourselves, but the change in their conditions of life from southern British Columbia to the Yukon district, had proved too much for them, and they had dropped off one by one. Three of the six could go no farther, and Inspector Jarvis kindly loaned us three others in their place to take us down to the coast. Pyramid Harbour was reached on September 25th, Skagway on the 26th, and Ottawa on the 13th of October. Animals exhausted.

"During the season, from the time of leaving Pyramid Harbour until my return to the same place, I travelled about 1300 miles. A geological examination of the country was made throughout most of this distance, and new surveys were made aggregating 300 miles in length. A large number of photographs were also taken, showing the general character of the country traversed, the appearance of the rocks underlying the country, the gravel terraces, the hill and valley gold-claims, the mode of sinking shafts, of making open cuttings, of rocking and sluicing gold, etc. New surveys made.

"Fifty-one species of plants were collected, and these have since been determined by Mr. J. M. Macoun. Of these (1) *Parrya macrocarpa*, (2) *Phlox Richardsonii*, and (3) *Gentiana frigida* had not before been found in the Yukon district, and the last-named not before in any part of Canada. The localities at which they were found were, respectively: (1) summit of Father Mountain, about 6000 feet, (2) Selkirk Trail, and (3) tributary of Nisling River, above the tree-line. Plants collected.

The Dalton Trail and its Vicinity.

"The country in the vicinity of the Dalton trail, may be divided into two parts, with topographical characters sufficiently distinct and persistent to be almost everywhere recognizable, viz.:—The Chilkat Ranges, a name here proposed for the high range of mountains extending north-westward and westward from the Lynn Canal and the table-land of the interior. Topography of Dalton trail.

"The Chilkat Mountains form a rough irregular range, extending inland for about a hundred miles from the main coast-line of the Pacific Ocean, which coast-line stretches south-eastward from Yakutat Bay to Cross Sound, and thence onward along the outer side of the Alaskan Archipelago.

"In the district at present under consideration, which lies north-west of the head of Lynn Canal, these mountains form an elevated region whose outer side descends more or less steeply towards the ocean, while many jagged, rocky peaks rise to heights of 6000 to 8000 feet above the sea.

Effect of glaciers.

"The mountains are intersected by deep valleys, of which the higher parts, lying at some distance back from the coast, are for the most part filled with vast fields of snow and ice, from which glaciers radiate in all directions, some descending steeply towards the coast, while others move landwards and give rise to some of the largest streams draining the country, notably to White River, and to many of the tributaries of Alsek River. The ice has, however, withdrawn or melted away from some of the valleys, and has left their sides with beautiful smooth well-rounded slopes. Of these ice-free valleys, none is more conspicuous or persistent than that which, in its outer coastal portion, is drained by the Chilkat and Klehini rivers; while farther inland its waters are collected into the Tatshenshini, or most easterly branch of the Alsek River.

Old Indian trail.

"In this valley, the Chilkat Indians of the village of Klukwan, and of the other villages on the banks of the Chilkat River, have for ages had a foot-path by which they travelled between the coast and the interior, in order to trade with the more remote tribes living on the upper waters of the Alsek River. This path has been cut out and improved by Mr. J. Dalton, until there is now an excellent trail for pack-horses from the coast into the interior, appropriately known as the Dalton trail.

Height-of-land.

"This trail follows the above-mentioned valley from Pyramid Harbour to Klukshu Lake, a distance of about 120 miles, running in a general north-westerly direction diagonally through the Chilkat Mountains. In this valley the height-of-land, which is at a distance of seventy miles from Pyramid Harbour, has an approximate elevation of 2650 feet above the sea, being more than 200 feet lower than the summit of the White Pass, and 850 feet lower than the summit of the Chilkoot Pass, while at the same time, being more distant from the coast, the approach to it is much more gradual.

Character of wide valley followed.

"The height-of-land, or water-parting, is hardly recognizable as such, being only a wide, flat, swampy portion of the bottom of the valley.

Beyond it, the valley declines gradually north-westward, with a slope of about twenty-five feet to a mile, without any abrupt break or dip of any kind. Its bottom varies from half a mile to a mile or more in width, and its sides rise in gentle grassy slopes and terraces for a couple of thousand feet, above which tower mural precipices, and broken rocky cliffs.

" For about fifty miles from Pyramid Harbour, the valley is everywhere, except on the flooded land besides the streams, wooded with a dense coniferous forest ; but on the upland country, for the next fifty miles, very little timber is anywhere to be seen, the lower lands and the mountain sides being alike covered with short grass, or a dense growth of dwarf birch and willow.

Interior country.

" The interior table-land is also a decidedly mountainous country, but the slopes are more gradual. Most of the peaks are gently rounded, and there are no glaciers or permanent snow-fields, so that while a great number of peaks may be in view at one time, and though these peaks may in some cases rise as high as from three to four thousand feet above the bottoms of the adjoining and intervening valleys, the whole landscape has the appearance of a hilly or lumpy upland, the higher portions covered with grass or scrub, while groves of dark, green spruce may partly cover the bottom-lands. In many places, level terraces follow along the sides of the mountains, forming wide and easy steps, which are usually thinly wooded with poplar, or covered by a rich grassy turf. These dry, thinly wooded terraces, and in fact much of this inland region, reminds one strongly of parts of the attractive country near the banks of the Saskatchewan River, east of the Rocky Mountains.

Continuation of wide valley.

" The wide valley mentioned above, continues northward through this interior table-land. North of Dalton post, it is drained by the Unahini River, beyond which lies Lake Dezadash, and that branch of the Alsek River which flows from it. From the north bend of the Alsek, one branch of it continues across to the Mendenhall, and thence down the Nordenskiöld to the Lewes, but another branch would appear to turn northward down the Alsek, then northward up the Aishihik River to Aishihik Lake, over Aishihik Lake, and along the wide flat valley north of it to Nisling River, down NislingRiver to White River, and down White River to the Yukon River ; having a remarkably direct course throughout the whole distance. This valley, whether entered at Pyramid Harbour, or at some point which may be easily reached by the White Pass, is undoubtedly the shortest and easiest known route from the coast to the heart of the gold district of the Klondike.

A direct route.

Plants and animals.

"Many natural fruits common east of the mountains, here grow and ripen in great profusion, and it seems not at all impossible that most, if not all, the grains, fruits and vegetables that will ripen in the Edmonton country will also ripen along this portion of the Dalton trail.

"Wild animals, as a rule, are rather scarce, but one small mammal proved to be of more than ordinary interest. This was a ground-squirrel, (*Spermophilus empitra*), which was very common on the terraces, everywhere from Rainy Hollow north to Rink or Five Finger Rapids, its burrows being conspicuous on all the dry places. In these burrows the animals live and continue active both in summer and winter, and in order that they may be warm and comfortable, the burrows invariably descend below the limit of frost. Consequently, wherever they are found, the frost cannot be more than a few feet deep, or such a depth as the ground would freeze in winter and thaw again in summer. Now where the ground is permanently frozen the frost extends to great depths, and therefore, wherever these ground-squirrels can burrow and live the ground is not permanently frozen. On all the dry benches and uplands, as far north as Rink at all events, there is no permanently frozen ground, although many of the boggy places, whether in the bottoms or on the sides of the valleys, are certainly underlain by frozen ground throughout the year. The fact that these benches are not permanently frozen, removes one of the strongest objections that has been raised to successful hydraulic mining in the Yukon District.

Rink or Five Finger Rapids.

Geological features.

"The rocks observed in the south-western portion of the Yukon district, range in age from the Archæan up through the Palæozoic, Mesozoic and Tertiary to Pleistocene sands and gravels, and in character they include granite, diorite, porphyry, porphyrite, diabase, trachite, rhyolite, basalt, lava, volcanic ash, mica-schist, sericite-schist, argillite, marble, quartzite, conglomerate, sandstone, etc., the last seven being more or less altered aqueous sediments which had been deposited one above another in the seas of the different geological epochs.

Granites.

"A massive gray and reddish-gray granite forms the main structural axis of this country, extending as it does north-westward from the head of Lynn Canal, past Lake Dezadeash, and away to the westward of Aishihik Lake. This is doubtless a continuation northward of the granite of the Coast Range of British Columbia, and like it is very barren of minerals of economic value.

Rocks overlying granites.

"Resting on or against the granite, and often very much disturbed and altered by it, is a dark argillite, interstratified with heavy beds of white crystalline limestone. In many places the argillite passes

below into a highly crystalline mica-schist. These schists and argillites are usually cut by veins and stringers of quartz. Wherever they underlie the country, gold can usually be washed out of the sand in the bottoms of the valleys. Thus they appear to be everywhere, to some slight extent at least, impregnated with gold. They are very widely distributed, extending from the west side of Lynn Canal up the west side of the Chilkat and Klehini rivers, along the north-west side of Tatshenshini River, through the Dalton Range, and northward, past Aishihik Lake to the Nisling or Tahté River, beyond which they are probably continuous with the schists that outcrop along the banks of the Yukon, from the mouth of Selwyn River to Dawson.

Porphyrites.

" One of the most conspicuous and wide-spread rocks in the district, is a dark-green porphyrite, which has broken through and altered the argillites and limestones above mentioned. It composes the mass of many of the highest and most conspicuous mountains in this portion of the interior, among which are mounts Maloney and Fairview, while the Sifton Mountains are said to consist largely of the same material.

Glaciation.

"North-eastward, as far down the Lewes River as Rink Rapids, the country has been more or less severely glaciated, by an ice-sheet that extended inwards from the high ranges bordering its coast. This ice-sheet pared down many of the inequalities of the surface, and deposited a thick coating of unstratified boulder-studded clay or till in the bottoms of the valleys. Where the till has been chiefly derived from the argillites or mica-schists, as in parts of the valley of the Kaskawulsh River, it appears to contain a small amount of fine gold, some of which may eventually be recovered by inexpensive hydraulic processes.

Terraces.

" Terraces of stratified clay, sand or gravel are common on the sides of some of the valleys, where they have been formed in lakes that existed at the foot of the great ice-sheet, or by streams that flowed from it. Some of these contain gold, where the deposits composing them have been derived from argillites or mica-schists.

Gold.

" Specimens of coarse gold, were shown to the writer as having been taken from Alder Creek and other streams in its vicinity. The country-rock is reported to be an argillite or mica-schist, and the gold has doubtless been derived from it. Whether it occurs in large quantities or not is as yet uncertain, but the question is deserving of further investigation.

Native copper

"For some years past, it has been reported that native copper was to be found on some of the upper tributaries of White River. An effort was made to visit the locality, but the coddition of our horses, rendered

our progress through the country very slow and thwarted this object, though we reached the valley of White River at the mouth of Nisling River. Here some Indians whom we met, and who had some small masses of native copper in their possession, reported that the copper country was still six days' journey distant, and that the copper was invariably picked up in the gravel on the stony flats beside the stream. This report of its mode of occurrence agrees closely with other accounts which were received. Its occurrence *in situ* is not yet known, but quite probably it is associated with a basic igneous rock such as the porphyrite mentioned above.

Copper ores.

"Early in the year, fragments of copper-pyrites were observed among the gravel-wash from a glacier, a short distance south of Glacier Camp. On my return in the autumn to the camp of the Mounted Police at Pleasant Camp, I was shown some fine specimens of bornite and chalcopyrite, with galena, which were said to have been found near Rainy Hollow. These discoveries would appear to indicate the existence of deposits of native copper or copper ore which may, in the near future, be of great economic importance."

Work by Mr. R. G. McConnell.

After his return from the field in 1897, Mr. R. G. McConnell was employed during the greater part of the winter and spring in working up the notes and collections made by him and his assistants in West Kootenay. When it was determined to undertake explorations in the Yukon District, part of which he had previously traversed in 1887, he was assigned to this work. His instructions were to make a geological reconnaissance by the chief eastern tributaries of the Lewes River and of the country adjacent to these, as well as a preliminary examination of the geological features of the route between Teslin Lake and the Stikine. He was also to devote a portion of the season to a general inspection of the geological conditions on the richly auriferous creeks of the Klondike region. All the main objects thus outlined were successfully covered during the rather short available season. The results are given as follows by Mr. McConnell:—

"I left Ottawa on May 13th for the Yukon district, accompanied by two Indians from Lake Temiscaming, who acted as boat-men and proved to be both capable and trustworthy. We reached Vancouver on May 19th and Dyea on May 27th. Our outfit, consisting of four months' supplies for three men, a Peterborough canoe and a canvas boat, was taken across the Chilkoot Pass from Dyea and landed at the head of Lake Bennett by the Chilkoot N. & T. Co. in three days. The ice on the lake broke up in the first week in June, and we were able to proceed immediately down the river. We left the head of Lake Bennett carrying our outfit in the canoe and

Crossing the Chilkoot Pass.

canvas boat, and reached the mouth of the Big Salmon without accident on June 12th. From this point a traverse and geological examination was made up the Big Salmon to the head of Quiet Lake.

"The Big Salmon has an approximate length of 142 miles, to the chain of lakes at its head, or, including the latter, a length of about 170 miles. Its width varies from thirty to a hundred yards. In a few reaches, it is a smooth, placid stream with an easy current, but for most of its length it is shallow and rapid, interrupted by numerous sand-bars and gravel-bars, over some of which the river has a fall of several feet. Rapids occur at the mouth of the North Fork and at another point about seventy miles further up, but can be easily run by small boats, except at low water. The Big Salmon cannot be considered a navigable stream for steamers, even at high water, and at low water small boats, when loaded, find difficulty in navigating it. Big Salmon River.

"For forty five miles above its mouth, the Big Salmon occupies a wide wooded valley bordered by rounded hills. Above that point it turns to the east and enters a wide range of mountains, through which its valley runs from its source in Quiet Lake. The direction of the river for the first thirty or forty miles above the South Fork, is generally transverse to that of the mountain ranges, but is parallel to them further up. The valley becomes much narrower after the mountains are entered, being in some places reduced to a width of less than a third of a mile, and is bordered by steep-sided mountains and mountain ranges from 3000 to 4000 feet in height above it, on some of which patches of snow exist in sheltered nooks throughout the year. It is terraced up to heights of from two to four hundred feet along its entire course. Character of the valley.

"The main tributaries of the Salmon are the North Fork, entering about twenty-five miles above its mouth, the South Fork, which comes about twenty miles further up, and a stream which joins it from the east a short distance below the lake. Besides these a number of large streams, heading in the adjoining mountain ranges, join it at various points along its course. Tributaries.

"The Salmon River heads in a chain of lakes about twenty-eight miles in length, connected by short streams with little current. The highest lake is the largest and is known as Quiet Lake. It is about nineteen miles in length with a maximum width of two and a half miles. The depth was not measured, but the lower, or Island Lake, gave a maximum sounding of 138 feet. Quiet Lake is bordered on the west by high mountains, and on the east by a rolling plain that extends to the Nisutlin River, four to five miles distant, and is broken by a number of rocky hills, the highest of which rises 1900 feet above it. The Lakes at head.

valleys of the Salmon and the Nisutlin are united at the upper end of Quiet Lake and also at Island Lake. The longer diameter of the latter is transverse to the general direction of the rivers, and follows an old valley connecting the two streams, now filled up with glacial deposits.

Forest

"The valley of the Salmon is generally fairly well forested along the bottoms and up the mountain slopes to heights of from 1500 to 2000 feet above the river. The principal forest trees are the white and black spruce, the former often attaining a diameter of a foot or more, the black pine, a variety of fir, birch, aspen and balsam poplar.

Geological section.

"The Salmon River valley, except for the first forty miles, affords a very good geological section. Below the North Fork, the valley is wide and exposures are infrequent. The rocks seen consist of greenish tufaceous sandstones, passing into agglomerates and slates, cut by diabases, and a whitish porphyritic rock of geologically recent appearance. At the North Fork, a range of hills four miles east of the Salmon, consists of reddish medium grained granites, and the same rock is reported to occur eastward along this stream for a number of miles. Between the North and South forks, no outcrops were noticed. Above the South Fork, the valley enters the mountains, becomes narrower, and exposures are frequent. The rocks above the South Fork consist of micaceous schists, quartzites, greenish schists and limestones, cut by granitic dykes. The dips are vertical or to the west. The green schists and associated rocks are succeeded, in going up the river, by a wide band of dark slates and schists interbanded with green schists, and further on by whitish granular limestones. The limestones are cut by a wide band of grayish granite. They dip to the east, except near the granite, where they are vertical, and are underlain by a great thickness of quartzite and micaceous schists alternating with bands of crystalline limestone. These rocks resemble the Shuswap series of the Selkirk Range. They are bent up into a great anticline, and are exposed, with little variety in composition, for many miles along the valley. The axis of the anticline crosses the Salmon near a great bend which the latter makes to the north. Above that point the dips are to the east. The Shuswap schists are overlain about forty miles below the lakes, by a limestone band similar to that which occurs in the western limb of the anticline. The limestone is exposed along the river for some miles and forms conspicuous mountain ranges on both sides of the valley. It is succeeded, in ascending the river, by dark slates and schists holding bands of greenish tufaceous beds and some limestones. The tuffs in places have been altered into serpentines. The slates and associated green schists are exposed along the Salmon to the

Granites. Stratified rocks. Great anticline.

lakes and along the lakes to a point about half way up Quiet Lake, where they are cut off by a great granite area which can be traced southward along the Nisutlin River to Teslin Lake. *Another granite mass.*

"The rocks of the Salmon River anticline consist, in a general way, of three great divisions. A basal series of quartzitic and micaceous schists and crystalline limestones, an intermediate granular limestone, and an upper division consisting of dark slates, green schists, tuffs, limestones and serpentines. No fossils were found and it is impossible to fix the age of these formations with any certainty. *Sequence of strata.*

"A number of prospectors ascended the Salmon during the summer, but most of them were inexperienced, and little effective work was done. Several shafts were commenced, but the influx of water prevented deep sinking, and none of them reached bed-rock. Fine gold is found all along the Salmon, and a number of the bars below the North Fork have been worked sucessfully during low water in former years. Coarse gold was stated to have been found in a couple of places in the lower part of the river, but I was unable to verify the reports. Fine colours were obtained in the wash of many of the streams emtying into the Salmon, and on a bar at the mouth of the stream which joins the latter three to four miles below the lakes, a very good prospect was obtained. Small quartz veins cut the schists in a number of places, and at one point west of Island Lake, several large veins cutting a dolomite band were noticed. Specimens of this quartz were collected but have not yet been assayed. An angular fragment of drift quartz, holding gold, was found at the mouth of a stream about twenty miles below the lake. The country in the neighbourhood of the upper part of the Salmon, based as it is on old schists cut by great eruptive masses, offers a very favourable field for prospecting, both for quartz and placer gold. It was run over by a number of people during the past summer, most of whom, however, had little knowledge of any branch of mining, and very little genuine prospecting was carried out. *Prospecting for gold.* *Quartz veins.*

"After finishing the examination of the Salmon, I went down the Yukon to Dawson, and spent two weeks in a hasty examination of a part of the Klondike region, some notes on which is given in another part of this report. From Dawson I came up the Yukon in a steamer to the mouth of the Salmon, and spent the remainder of the season on Teslin River, Teslin Lake, the Nisutlin River and the Teslin trail. *Descend river to Dawson.*

"The Teslin or Hootalinqua River is one of the main feeders of the Yukon. It is a large stream, averaging about 125 yards in width when confined, but widening out around islands, and with a length, according to Mr. St. Cyr's survey of 1897, of about 100 miles. The current is pretty *Teslin or Hootalinqua River.*

swift for the first seventy miles, running from three to five miles per hour, with occasional accelerations where bars cross the stream. Thirty miles below the lake, the grade lessens and the current drops to less than two miles an hour. No rapids occur on the Teslin, but bars are frequent and on some of these the water in the autumn is so shallow as to interfere with navigation. The steamer *Anglian* which was built on Teslin Lake, descended without much difficulty in the early summer, but was unable to ascend again towards the end of August, on account of the shallowness of the water on the bars. The Teslin differs altogether in character from the Lewes. The latter is fed largely from the glaciers of the Coast Ranges and remains fairly high until the cold weather sets in. The Teslin, on the other hand, has no such reserves to draw upon. It rises in May with the melting of the snows, is in full flood about the first week in June, and then falls steadily, as the lakes are gradually emptied, throughout the season. The summer of 1898 was an exceptionally dry one, and it is claimed that the Teslin was lower than usual on this account, and that in ordinary seasons its navigation is practicable until late in the autumn. This is quite possible, but as no good records for preceding years exist it is still an open question.

Navigation of Teslin.

Teslin valley.

"The valley of the Teslin averages about a mile in width, from the mouth up to within a few miles of the lake, where it widens out to about two miles. It is bordered by high lumpy hills and low mountain ranges throughout its whole length. Between the river and the base of the hills, is a series of flats, the highest of which has a remarkably uniform elevation all along the river of from 300 to 320 feet. The immediate banks of the river are generally terraced, but high cut-banks of white and light-yellowish silts and boulder-clay occur at the elbows of some of the bends.

Geological section.

"The geological section along the Teslin is not very satisfactory, as the course of the river is almost parallel to the strike of the rocks. Near the mouth, and for some miles up the river, a recent volcanic rock outcrops, the character of which has not been determined. It incloses fragments of slate and is succeeded by a band of crushed and altered slates. The slates are followed by reddish-weathering tuffs and agglomerates, and frequent exposures of these rocks, alternating with slates, appear along the river or on the hill-sides nearly all the way to the lake. They inclose occasional bands of nodular limestone. At the mouth of Boswell River, which enters the Teslin from the east, a conspicuous range of bold mountains is built almost entirely of grayish and reddish-weathering limestone. Above Boswell River, dark and greenish slates and schists, tuffs and other old volcanic fragmental rocks resume and continue to the head of the river.

"Fine gold is found in a number of bars and beaches along the Teslin, but as a rule in inconsiderable quantities. Some work was done on a few of the bars during the past season, but the results were stated to be not very satisfactory. The streams entering the Teslin are few in number and with one or two exceptions insignificant in size, and as they do not as a rule traverse an especially promising gold country, it is probable that the gold in the Teslin gravels is largely derived, from the washing away and concentration, by the river, of the glacial and stream deposits which floor the valley. Occurrence of gold.

"The Nisutlin River was traced into the Pelly Mountains, and the branch followed was found to head within twenty miles of the Pelly River. The Nisutlin enters Teslin Lake about thirty miles above its lower end, and is its principal feeder. It has a width of from 200 to 400 feet. The current is swift to the first fork, a distance of about three miles, above which, for many miles it does not exceed two to three miles an hour. The river winds, in its lower reaches, through a low, alluvial plain, apparently a filled-up bay of the lake, which gradually narrows to the north. The valley is wide, often exceeding ten miles, and is bordered by low round-topped mountains rising from 3000 to 4000 feet above it. A wide forested plain spreads from the immediate valley of the river to the foot of the mountains. The river is crossed by numerous shallow sandy bars in this lower part, and by gravel bars further up where the current is swifter. The water on many of these was found to be too shallow to allow of the navigation of the river by steamers of any size, late in the season. Nisutlin River. Nisutlin valley. Navigation of Nisutlin.

"The Nisutlin valley has a nearly north-and-south direction from Teslin Lake to a point opposite Quiet Lake on Salmon River, a distance of about seventy-five miles. The valley still continues to the north above this point, and is occupied by a fork of the Nisutlin, but the main river bends suddenly to the east and follows a north-easterly course through a wide range of mountains that extends north-eastward almost to the Pelly. The Nisutlin, after entering the mountains, becomes narrower and swifter, steep bars are frequent, and long bouldery rapids render its navigation, even with small boats, difficult and dangerous. We cached our canoe at the foot of one of these rapids and continued the exploration on foot. Rapids.

"About twenty-five miles from the point at which the mountains are entered, the river again forks. The main branch comes from the east and appears to head in a wide lake-dotted plain, a view of which was obtained from the summit of a high mountain at the forks. The route from the Liard leads down this branch. The left fork, which was the one followed, as it promised a better geological section, breaks through Plain.

the range in a north-easterly direction. Above the forks just mentioned, the branch we ascended dwindles rapidly in size as numerous feeders from both sides are passed. About twenty miles from the forks we turned up a small stream flowing from the summit range, and five miles further on reached the Nisutlin-Pelly watershed. This was crossed by a good pass about 4000 feet above the sea, flanked by rugged mountains about 3000 feet higher. We continued on down a stream to the north, for about seven miles, and then returned. From the summit of a mountain opposite our last camp, the Pelly was seen flowing in a wide valley, at a distance of about twenty miles. The Pelly Range, where crossed, runs nearly east-and-west. South of the divide, it consists of a number of well-defined subordinate ranges striking east-and-west. North of the watershed, it has been carved into a confused mass of mountains and mountain groups by a number of branching streams tributary to the Pelly. Some of the peaks in the watershed and adjoining ranges exceed 7000 feet in height. The valley and lower slopes of the mountains are generally wholly or partially wooded up to a height of about 3000 feet above the sea. Above that point, grassed and moss-covered slopes and bare peaks and ridges prevail.

Pelly River.

Character of Pelly Range.

Geological section on Nisutlin.

"The Nisutlin River, until it leaves the main valley east of the Salmon lakes, does not afford a good geological section. The valley is wide, and the river is bordered by wide wooded flats composed of alluvial or glacial materials. Occasional traverses were made to the mountain ranges, on both sides, on the way up, and some data were collected, but the section is incomplete. Greenish volcanic rocks, usually more or less schistose, occur along Nisutlin Bay. At the head of the bay, a wide band of granite crosses the valley. In the lower reaches of the river, green schists outcrop in a few places along the valley, and then exposures cease. The mountains west of the valley are composed principally of grayish granite and form part of the great granite area, mentioned before, that stretches from Quiet Lake south, to, and along Teslin Lake. The granite crosses the valley and outcrops in the mountains east of the Nisutlin above the first fork, and extends north about half way to Quiet Lake. Above that point, green schists interbanded with limestone come in, and are exposed in the ridges east of the river for many miles to the north. Greenish schists, cut by granite dykes from the Quiet Lake granite area, also outcrop in some small hills on the portage from the Nisutlin River to Quiet Lake.

"Above the point at which the Nisutlin bends to the north-east and cuts across the mountain ranges, exposures become more frequent. Green schists and dark slates, interbanded with some limestone or

dolomite, outcrop for several miles, and are succeeded by a coarse-grained, reddish porphyritic granite which continues almost to the upper forks. Beyond the granite, green schists resume, and are succeeded by lead-coloured and black slates and schists and then by quartzites and dolomites. The dip is to the west and the section is a descending one. The quartzites and associated rocks are followed by a band of heavy limestone beds that forms a conspicuous range, and then by dark slates and schists, and green schists and limestones which continue to the summit of the Pelly Range. At the summit, the beds have an anticlined attitude. They consist there mostly of dark slates and schists, with some agglomerates, succeeded, on the north slope of the range, by green schists and limestones. A band of limestone three miles east of the summit contained some corals and fragments of other fossils which are probably of Carboniferous age. Old Cambrian schists such as occur on the upper part of the Big Salmon River, were not found on the Nisutlin, and the stratified rocks seem to belong mostly to the Upper Palæozoic, while some may even be of Mesozoic age.

Occurrence of gold.

"Mining operations on the Nisutlin, so far, have been confined to prospecting. Fine gold occurs along it at various points, but up to the present has not been found in paying quantities. A great development of quartz veins occurs south of the summit on the branch ascended. The veins are small but exceedingly numerous. They occur mostly in the dark slates, and schists and greenish schists. Quartz boulders and pebbles form the principal constituents of the gravels in the streams flowing from the range. The streams and mountains in this vicinity seem well worth prospecting.

Teslin Lake.

"The shores of Teslin Lake were hastily examined on the way out. This lake was surveyed by Mr. St. Cyr, D.L.S., of the Dominion Lands Branch, in 1897. It is a long, narrow sheet of darkish water, from one to two miles wide, and with a length, according to survey, of about sixty miles. A line of soundings across the lake north of Dawson Peaks gave a maximum depth of 435 feet. The bottom of the lake, outside the steep shore-slope, is a nearly level plain covered by about 400 feet of water. The lake is almost completely encircled by medium-sized mountains and mountain ranges, the most prominent of which are the Dawson Peaks, known locally as the 'Three Aces which are situated about half way up the lake, on the west shore, and have an elevation of 3800 feet above the lake. The mountains are separated from the shore of the lake by a wooded plain of varying width, and at Hall River a lake-sprinkled area of rolling country extends some distance to the south-west.

Rocks on Teslin Lake.

"The rocks along Teslin Lake are very similar to those on the Nisutlin River. They consist of green schists, tuffs, agglomerates and limestones. Grayish granite, somewhat similar to the gray granite of the Kootenay country, occurs along the east shore of the lake, south of Nisutlin Bay, and a spur crosses the lake and is exposed opposite to and in the Dawson Peaks. Granite also comes in on the west shore of the lake two miles below the Narrows and extends south to near Hayes River. Above Hayes River, dark slaty rocks, tuffs and limestones resume, and continue to the head of the lake.

Trail to Telegraph Creek.

"From the head of Teslin Lake we came out by the Teslin-Stikine trail to Telegraph Creek. This trail has a length of about 151 miles, and with the exception of about fifteen miles in the vicinity of Spruce Mountain, has been well graded and corduroyed throughout during the past summer, and is now in excellent condition. A partial examination was made of the rocks along the trail. From the head of Teslin Lake to the Naylin River, a distance of about fifty-seven miles, the beds consist of a succession of rusty-weathering, dark, slaty rocks, tuffs, green schists and grayish limestones. The Naylin River valley, at the trail-crossing, cuts into yellowish-weathering, soft sandstones of Tertiary age. Drift lignite occurs on the bars, but no beds were seen. South of the Naylin River, the Tertiary sedimentaries are succeeded by dark and greenish massive volcanic rocks, often slightly schistose and occasionally partly serpentinized, and further on by dark slates and greenish tuffs and conglomerates. At the 'Hudson's Bay' summit and for some miles to the north, the surface is covered by comparatively recent sheets of volcanic rocks. Three distinct flows are represented by an older compact basalt, a light-coloured acidic rock, probably a rhyolite, and a younger vesicular basalt. The wide plateaux of Level Mountain on the east and the Heart Mountains on the west of the trail are composed, in part at least, of similar rocks. East of the Hudson's Bay post, the valley of Hacket Creek is bordered above by basaltic cliffs on the north side, and by andesites and other porphyritic volcanics below. Pyrite, pyrrhotite and chalcopyrite are found in small quantities in these rocks. Farther to the east, tuffs, agglomerates and allied rocks partly replace the massive volcanics. At the 30-mile post, a band of yellowish-weathering dolomite crosses the trail. From the Tahltan River across the Telegraph summit to the Stikine, the rocks consist principally of fine-grained greenish tuffs, agglomerates and conglomerates, cut in places by augite-porphyrites and other massive volcanics of greater antiquity than those above referred to.

Drift lignite.

Basaltic rocks.

"While delayed at Telegraph Creek, an examination was made of some claims on Nine-mile Creek, nine miles above Telegraph Creek, that have excited considerable interest. These claims have been staked out on a boss of eruptive rock, probably a diorite, about a third of a mile in width. The diorite varies from fine to coarse-grained in texture, is very basic and is filled in places with magnetic iron. It is bordered by greenish volcanic rocks, probably altered tuffs, on the west, and by a syenitic or granitic area on the east. Dykes of the last-named rocks penetrate the diorite in all directions, and occasionally carry small pockets of bornite and other copper minerals. A few small quartz veins also occur, but are unimportant. A number of specimens of the diorite, collected at different points along the face of the exposure, have been assayed, and are stated to have yielded from traces up to over a hundred dollars in gold to the ton. A further examination of a larger quantity of the gold-bearing rocks is now being made by Mr. J. C. Field, M.E., for the North American Exploration Company, and if the results of the previous assays are borne out, it will have an important bearing on the district, as the supply of material is almost unlimited. Assays of the specimens collected by myself will also be made in the Survey laboratory. Claims on Nine-mile Creek.

"Work for the season was finished at Telegraph Creek. From that point we came down the Stikine in a small boat to Wrangel, and returned to Ottawa."

Preliminary Note on the Gold Deposits and Gold Mining in the Klondike Region, Yukon District.

Messrs. R. G. McConnell and J. B. Tyrrell are jointly responsible for the following memoranda and observations bearing more directly on the question of the gold deposits and connected matters, the principal gold-bearing creeks of the Klondike having been visited by these gentlemen in company.— Klondike region.

"The productive part of the Klondike Gold District, as at present known, covers an area of 1000 square miles, and is situated between the Klondike and Indian rivers, tributaries of the Yukon, and east of the latter river. The region is traversed by a multitude of streams, flowing for the most part in deep trough-like valleys, among the most important of which are Bonanza Creek, (with its rich tributary Eldorado,) Bear, Hunker, Too Much Gold, and All Gold creeks, flowing into the Klondike; and Dominion, Sulphur and Quartz creeks, branches of Indian River. The larger creeks are separated by long ridges gashed by the smaller streams and terminating upwards in even slopes or lines Topography of the region.

of rounded hills. The general aspect of the district, viewed from one of the higher elevations, is hilly, owing to the fact that the main ridges and creeks radiate out in a general way from a central point known as the Dome. The main ridges rise above the valleys from 1200 to 1500 feet, and in places are somewhat higher. The Dome, a name given to the prominent hill surmounting the ridge separating the tributaries of Indian River from the Klondike, and one of the highest points in the region, has an elevation above the Yukon River of about 3000 feet. East of the hilly region centring in the Dome, at a distance of eight to ten miles, is a wide plain drained by a branch of the Klondike, beyond which, and closing in the horizon, runs a high range of rugged peaks. The district, with the exception of the higher peaks and ridges and occasional flats along the streams, is covered with a fairly heavy forest growth, consisting principally of the white and black spruce with some birch and poplar.

Productive area.

"*Productive area.*—The approximate area of 1000 square miles, given above as the probable extent of the known gold-field, refers to the district traversed by the gold-bearing creeks, and not to the actual area of pay gravels. The latter are confined to the bottoms of a few of the valleys and the lower slopes of the adjoining ridges and occupy a much smaller area. The rich creeks, so far, are only four in number, viz.: Eldorado, Bonanza, Hunker and Dominion, and by far the greater proportion of the remarkable yield of the last two years has come from Eldorado and Bonanza. The proved portions of the four producing creeks have an aggregate length of about thirty miles. A number of tributaries of the producing creeks, and other streams such as Bear, Sulphur, Two Much Gold, All Gold and many more, have yielded small amounts, and it is confidently expected that the prospecting work now in progress will result in large additions to the producing area.

Occurrence of gold.

"*Mode of occurrence of gold.*—The gold occurs in the gravels flooring the bottom of the valleys, in stream-terraces lining the lower slopes of the valleys and in a remarkable moraine or glacial deposit that occurs along the southern slopes of Eldorado and Bonanza creeks for some miles, and was also found north of the latter creek for some distance above its junction with Eldorado.

Stream-gravels.

"The stream-gravels are very uniform in character throughout the district. They consist mainly of flattened sub-angular schist pebbles, ranging in size from small scales up to rounded or elliptical plates a foot or more in width, coarse round pebbles and boulders of quartz and occasional layers of clayey vegetable mould. The gravels rest on a slightly irregular floor of decomposed mica-schist and quartz-schist. They have a thickness of from two to eight feet and a width along the

most productive portions of Eldorado and Bonanza creeks of from one hundred to four hundred feet. They extend across the valley-bottoms and increase in width with the gradual enlargement of the latter towards their mouths.

"The gravels are overlain in all cases by a layer of black argillaceous vegetable matter of three feet or more in thickness.

"The gravels are everywhere more or less auriferous, but, as in other placer camps, the concentration is very irregular, and the gold increases in quantity towards the bottom of the section, the greater part of the pay being found usually within eighteen inches or two feet of bed-rock. A considerable portion of the gold is also found in the soft decomposed and shattered country-rock on which the gravels rest, into which it has sunk often to a depth of two feet. The pay-streaks range in width from a few feet to a hundred feet or more. They are interrupted along the length of the creek by comparatively barren stretches, and in places more than one pay-streak is found in prospecting across the rocky bottom. The minimum richness of the gravels considered as 'pay' by the miners, on an average claim, is given at about $5 to the cubic yard, but varied according to different informants from $4 to $7. Width of pay-streak.

"The bench-gravels are of less importance than the stream-gravels and so far are only worked to an inconsiderable extent along Bonanza and the lower part of Eldorado Creek. The benches only occur at intervals along the sides of the valley and as a rule are rock-cut and not built up by stream deposits. They are found at varying heights up to an elevation of seventy-five feet or more above the bottom of the valley. Bench gravels.

"In ascending Bonanza Creek the first bench claims were found opposite No. 60 below Discovery, on the south side of the valley. The bench has an elevation of seventy-five feet above the bottom of the valley and consists of sixty-seven feet of schists of various kinds terminating upwards in a flat surface and overlain by eight feet of gravels. The bench is wide, as it occurs on a projecting point, but does not extend far along the valley. The gravels are mixed with sand and consist of flat and sub-angular pebbles of schist often a foot or more across and rounder quartz pebbles. The gold is fine, but nuggets up to a value of $1.35 are reported to have been found. The average yield of the gravels is stated to vary from 5 cents to 20 cents to the pan. Several bench claims similar in character to the one just described, but at lower elevations, were being worked further up on Bonanza Creek and on the lower part of Eldorado. On Hunker Creek, only one claim of the kind was being worked at the time of our visit, and on Dominion Creek none were in operation.

Hill claims.

"Hill claims, situated on the moraines mentioned above as occurring along Bonanza and Eldorado creeks, are being extensively worked and in some cases have proved extremely rich. The moraines are situated at an elevation of from 150 to 200 feet above the bottom of the valley, have a width of from 200 to 300 feet or more and a thickness in the centre of 50 feet or more. The most productive claims occur along the lowest edge of the deposit and are worked by open cuts. The gravels are washed in rockers as the water supply is insufficient for sluicing. The morainic material is auriferous throughout, but the greater part of the gold is found at or near the sloping surface of the bed-rock at the bottom of a bed of coarse gravel, which consists of rock-flour, sand, pebbles and boulders. The gold, which is often in large nuggets, usually includes much quartz, and is rough and unrounded.

Character of deposits.

"*Conditions of working.*—As stated above, the stream deposits consist of beds of gravel varying from two or three to fifteen or twenty feet in thickness, overlain by a mass of vegetable material, locally known as 'muck,' from four to eight feet or more in thickness. This muck is chiefly sphagnum bog, or peat, which has suffered little decay since it grew where it now rests. Both the peat and the gravel are permanently frozen, and as the peat is an excellent non-conductor of heat, the gravel continues frozen as long as it remains covered by even a thin coating of peat.

Prospecting.

"After the prospector has found indications favourable enough to induce him to stake off a claim, he can readily prospect it thoroughly in winter by building a fire on the surface, removing the thawed earth, building another fire on the same spot, again removing the ground that has been thawed, and so on down to bed-rock. The sides of the shaft so sunk remain firm and solid. In summer, however, it is difficult to sink a shaft in this way, as the sides are likely to cave in, so that prospectors then build a fire upon the open ground, heat stones very hot and throw them down the shaft, covering them with brush or anything else that will prevent the heat from ascending. These stones will, in a night, thaw the ground to a depth of from 6 to 9 inches. This thawed ground is taken out, and the process is repeated until bed-rock is reached. If pay gravel is struck it may be thawed and removed from around the bottom of the shaft until a large circular 'room' is ormed in the gravel. The gravel raised is afterwards sluiced, and the gold extracted from it.

Working creek claims.

"The most economic method of working creek claims is by open cuts. The barren muck overlying the gravels is got rid of early in the season by the simple device of damming up the stream and leading it by several channels across the claim. The frozen muck dissolves readily

and is usually completely removed by the stream in the course of a few week. The underlying auriferous gravels, as they become gradually thawed out and loosened by the sun and the various atmospheric agencies are shovelled into sluice boxes and washed in the ordinary way. When the surface is kept clean thawing proceeds at the rate of from two to four inches a day and bed rock is reached before the season closes.

"On the dry benches in the northern part of the Yukon district, the ground was found not to be frozen in summer, and probably some of the drier and more open tracts in the Klondike district are not permanently frozen.

Poorer gravels.

"On the hill-sides, as well as in the bottoms of many of the valleys, there are large quantities of earth and gravel that are too poor to admit of being worked by the ordinary method of sluicing or rocking now in use, and to yield good results will require to be worked on a larger scale and by more economical methods.

Scarcity of water.

"The clays and gravels when exposed in summer in the creek beds and on the hill-sides, thaw very quickly leaving them loose and friable and in a favourable condition to be acted on by water. The available water in the Klondike creeks is however too limited for work on a large scale and the problem of obtaining a supply from other sources has not yet been solved. The grade of the Klondike River is fairly steep and it is possible that water might be flumed from it. This could only be done at a great cost, as the river would have to be tapped far up. The gravels are, however, exceptionally rich even in many portions of the creeks too lean to pay by present methods of working and would justify a heavy expenditure in their exploitation.

Capital required.

"To install extensive plants either for hydraulicing or sluicing blocks of ground, large sum of money will be needed, and in order to encourage the influx of this capital into the country it will be necessary to offer every facility to investors. It should thus be not only possible but reasonably easy for them to consolidate groups of claims or to obtain blocks of land of sufficient size to make it probable that they would receive a fair return for their investment, especially in the case of lands not sufficiently rich to be profitably worked by hand.

Gradients of streams.

"*Gradients.*—As the valleys are wide and U-shaped, the grades of their beds are not at all steep. The Forks of Bonanza and Eldorado creeks, about 12 miles from Dawson, is about 500 feet above the Yukon River at that place, giving lower Bonanza and the Klondike River combined an average grade for that distance of something over 40 feet to the mile. Bonanza Creek, from the mouth of Cormacks Creek to the Forks, has a drop of about 500 feet, giving a fall of a little less than

100 feet to the mile. The grade of Eldorado Creek is somewhat steeper, the descent from the mouth of Chief Gulch to the Forks, a distance of about four and a-half miles, being about 700 feet, or an average of about 150 feet to the mile.

Proposed reservoirs.

"Above these points, the grades become rapidly steeper and the streams are narrower, so that it might be possible to build dams across them and construct large reservoirs, from which a supply of water could be obtained to serve for washing the lower parts of the hill-sides further down.

The gold of local origin.

"*Source or sources of the placer gold.*—As has been pointed out by Mr. J. E. Spurr of the United States Geological Survey, in the case of the country of Forty-mile Creek and further north and west, the gold in the Klondike has certainly been derived from the rocks of the immediate vicinity, for there is no evidence of the transportation of material of any kind from a distance. The rock underlying the district is a quartzose micaceous and sericitic schist, in which many lenticular stringers of quartz lie parallel to the bedding, and through which some large veins of quartz run in other directions. In a few places dikes of dark-green basic rocks as well, as lighter coloured porphyries cut through the schist, but it is not probable that these intrusives have any influence on its gold-bearing character.

"On Bonanza and Eldorado creeks, one band of the schists is highly graphitic, while near the mouth of Hunker Creek there is a heavy band of granular limestone.

"Granite was reported to occur a short distance up the Klondike but the outcrop was not seen.

Age of auriferous schists.

"The schists are sedimentary or crushed massive volcanic rocks of early Palæozoic, probably Cambrian age, which have been highly altered by dynamic agencies, the quartz veins having doubtless been formed in them while they were undergoing this metamorphism.

"The rocks of this group have been traced northward and westward by the geologists of the United States Geological Survey into the Forty-mile and Sixty-mile district. Southward they have not as yet been exactly correlated with any of the rocks known to occur in Canada, though they may be of the same age as the schists and limestones on Nisling River and along other portions of the Dalton Trail.

Gold associated with quartz.

"That the gold in its original habitat has been associated with quartz there can be no doubt, for many masses of gold-bearing quartz have been found, and many of the nuggets of gold contain particles of quartz. Whether the gold is chiefly derived from the heavy veins or from the narrow stringers has not yet been determined, but it is

probable that in places both are auriferous. We found particles of gold in a thick quartz vein north of Eldorado Creek, but as the abundance or scarcity of the placer gold did not appear to depend on the size or number of these heavy veins, it is probable that the precious metal has been chiefly derived from the narrow stringers or leaves of quartz interbedded in the schist.

"The great ice-sheet of the Glacial period which covered much of British Columbia, did not reach as far north as the Klondike district, so that ever since the land was elevated above the sea, perhaps in the Miocene or Pliocene epoch, it has been cut down continuously by atmospheric and stream agencies forming deep valleys, with intervening rounded hills still covered by a varying thickness of decomposed rock. There is no doubt that much of this decomposed rock, in the Klondike area, contains a small amount of gold, and by constant washing for ages, much of this has become concentrated in the beds of the streams. On Bonanza and Eldorado creeks, and doubtless also on a number of the other creeks that rise in the high land near the Dome, the work of concentration has been greatly expedited by small local glaciers, which, at a period not very remote, have originated at the heads of these creeks, and have filled the bottoms of their valleys through parts at least of their lengths. Thus the Eldorado glacier would appear to have had a greatest thickness of about 200 feet at French Gulch, and to have joined the Bonanza glacier at the Forks, below which both continued on some distance together. The gravel that fills the bottom of the valley from side to side is a typical glacier-wash, having been deposited by the stream which flowed from the face of the glacier. The lower benches on Bonanza Creek were also deposited in a similar way, but the higher so-called benches, have been formed either as lateral moraines along the sides of the glacier, or by streams which flowed between the side of the glacier and the bounding slope of the valley.

District not glaciated.

Small local glaciers.

"The great richness of the Klondike placer ground depends, therefore, first, on the presence of a highly gold-bearing rock, and, secondly, on the occurrence of a set of conditions peculiarly favourable to the concentration of the precious metal.

"*Communication.*—Last summer it was necessary to transport provisions and supplies from Dawson to the various creeks on the backs of men or horses by trails through swamps, and along stony hill-sides which were about as bad as they could be. Good wagon-roads could, however, readily be built from Dawson up the various creeks tributary to the Klondike River and thence possibly across to Dominion Creek, and thus to the tributaries of Indian River. From the Yukon River a good wagon-road could in all probability be easily built from the mouth

Insufficient means of transport.

of Indian River up to the very sources of most of the tributaries. In fact, good and direct roads could easily be built through that whole country, for the hill-slopes are everywhere light and the bogs in the bottoms of the valleys are nowhere very deep, while lakes are conspicuously absent.

Wood supply. "*Fuel.*—The country is more or less thickly wooded with white and black spruce, white and black poplar, and canoe birch. The largest timber is in the bottom of the valleys, some of the white spruce on the flat near the mouth of Bonanza Creek forming a forest of fine tall trees fourteen to eighteen inches in diameter. Excellent timber also extends in places up the sides of the hills to a height of several hundred feet above the level of the Yukon at Dawson, the spruce being mixed with large white poplars. At higher elevations the forest becomes thinner and the trees smaller, until at an elevation of about 2500 feet above Dawson, the timber limit is reached, the higher crests and summits in the vicinity of the Dome being devoid of timber and clothed only with small hardy alpine and arctic plants. If used with reasonable care, there is an abundance of wood in the country to supply the wants of the people for a number of years both in fuel and building timber. The greatest care, however, should be exercised to prevent forest fires which might in a very short time deprive those who are attempting to develop the resources of that country of one of their most valuable assets.

Coal. "Lignitic coal or lignite is reported to have been found on Klondike River about forty miles above Dawson, but no definite information has been obtained about it. It is possible that there may be coal seams here which will furnish a valuable local supply of fuel.

Expenses. "*Cost of living.*—During the past year the expenses of working mines have been abnormally high on account of the scarcity of labour, and the very high prices of machinery and provisions, these prices being due not so much to the inherent difficulty and expense of transporting provisions into the country as to the fact that the means of transport into the country were quite inadequate to supply the people who swarmed into the Yukon district. This summer, however, wages had fallen to about a half of what was paid last winter, and it was found quite possible to purchase provisions at retail prices at the stores, for the maintenance of a party, at less than a dollar a day per man."

BRITISH COLUMBIA.

Mr. R. W. Brock, during the early part of the year, was employed chiefly in work connected with the compilation of the West Kootenay

map. Accompanied by Mr. W. W. Leach as topographical assistant, he left for West Kootenay on May 30th, to continue and extend the field-work necessary for the completion of the map-sheet laid out, which embraces a block of country extending from the 49th parallel northward nearly to the head of Kootenay Lake, bounded on the east by a line east of Kootenay Lake and to the west by a line west of Christina Lake. This map will therefore include the mining centres of Trail Creek, Nelson, Slocan, Ainsworth, Kaslo and several others, besides a portion of the Boundary Creek district. Map.

The portion of the map already completed, has been engraved on copper during the past summer, and when the additions due to last season's work have been made, it may prove to be desirable to print a preliminary edition of the map-sheet, although the completion of its whole area involves much further surveying work. The very rough and mountainous character of the country, renders it exceptionally difficult, and it must be remembered that the whole work of its topographical survey, as well as that of its geological examination, has had to be undertaken by the Geological Survey.

Mr. Brock reports as follows on the work of 1898 :—

"Attention was confined chiefly to that portion of the district which lies between the Columbia River and the Slocan and is bounded by the Nakusp and the Kootenay to the north and south. While the weather was unfavourable for work in this our main field of operation, a transit and micrometer survey was completed of the Arrow Lakes and the Columbia River, from the point, about five miles below Halcyon Hot Springs on Upper Arrow Lake, where the Dominion Lands Survey of the Columbia had been discontinued, to the International boundary at Waneta. In addition to this, a week was spent in the Beaver Mountains, situated between the Salmon, Pend d'Oreille and Beaver rivers, and, after the depth of snow on the mountains generally had rendered ordinary field-work impossible, I visited some of the principal mines in the Slocan district, with the view of collecting a representative suite of specimens of the typical ores of the district. District examined.

"The season was altogether unfavourable for mountain work, and we were, in consequence, unable to finish the Slocan slope of the district. On account of the late spring and the altitude of the mountains, the work was interfered with, first by snow, then by rains until well on in July. About the middle of August the smoke due to forest fires put an end, for the time being, to the topographical work in the mountains. It was then that the survey was made of the Columbia River and the Beaver Mountains. The smoke enveloped the moun-

tains until the latter part of September when it was dispelled by falls of snow.

Method of survey.

"The method adopted in carrying out the topographic work, was that followed in previous seasons, viz., transit triangulation, with sketches, from peak to peak, together with traverses of intervening and connecting trails, ridges and valleys. The framework thus constructed was connected with the work already done, by bearings on fixed points and also by tying in with Robson and with Nakusp Point, the positions of which had been already determined astronomically. The survey of the Columbia furnished additional data for this connection.

Topographical features.

"The character of the country examined is, like that of other portions of the West Kootenay district, mountainous in the extreme. Its special features are the steepness and altitude of its mountains and the narrowness and depth of its valleys. Only in a few places do even the main valleys, such as that of the Columbia and Pass Creek, widen, and for short distances present open expanses or meadows. It consists essentially of a block of mountains, which, rising steeply from the Columbia valley on the one side and abruptly from the Slocan on the other to a height of 7000 or 8000 feet, gradually increase in altitude towards the interior till they culminate in the Valhalla Range, a group of wild and rugged, glacier-bearing peaks.

"In the extreme south, the mountains are massive domes. Throughout all the central part they are lofty precipitous crags, of airy and fantastic form, supporting numerous glaciers and perennial snow-fields. In the north, on parts of Snow and Cariboo creeks, the mountains, while still high and steep, are often drift-covered and grass-grown, giving them a less rugged and more pleasing aspect. This is true particularly of the southern slopes, for, as a rule, throughout the district, the southern side of the mountains are steep, debris-covered slopes while the northern present bold, precipitous faces.

Drainage.

"The main drainage is by the short torrential streams that occupy the narrow deep-cut transverse valleys, heading usually in amphitheatres or cirques carved in the central range of peaks. The actual watershed between the Columbia and Slocan is sinuous, being close to the Slocan valley in the north, but soon sweeping over toward the Columbia and so on southward. It rarely drops below 7000 feet in height. The longest and most important transverse valleys on the Columbia slope, are those of McDonald, Cariboo, Snow and Long creeks in the north, and of Deer and Cayuse creeks and Pass valley in the south. The latter, paralleling the Kootenay and separated from it only by the wall of Sentinel Mountain, affords a very low, easy pass from the Columbia to the Slocan valley

near its debouchment on the Kootenay. Pass Creek, coming in from the north about the middle of this valley, now turns southward to the Columbia. Formerly it appears to have taken the opposite course, discharging into the Slocan.

Longitudinal valleys.

"While transverse valleys predominate, there are within the district two notable longitudinal valleys; one, the southward continuation of the valley occupied successively by Musquito Creek and the Columbia River above Burton City, is drained by Trout Creek, and the other, cut off from this by a spur from the Valhalla Range, but continuing the depression on southward in the same direction, is that of the Little Slocan. This stream drains a considerable area, receiving a large number of the transverse valleys on the Slocan slope in the central and southern portion of the district. Tarns and small lakes are numerous in the upper parts of the streams, being almost invariably found in the cirques at their heads, and occupying shelves of rock near the crests of the mountains. These little lakes, in the higher mountains remain frozen over almost the entire summer. In the Valhalla Range the multitudinous lakelets have the beautiful peacock-blue or green water peculiar to glacier-fed lakes. Lower down in the courses of the streams, lakes may also be found, formed by avalanches or moraines damming their valleys. Lakes of some size occur on Little Slocan, and one or two other streams. The Arrow and Slocan lakes have been described in previous reports of this Survey.

Lakes.

Vegetation.

"The forest growth is similar to that found in other portions of West Kootenay, also described in previous publications.* On the Columbia slope are a number of park-like expanses with a considerable growth of red pine (*Pinus ponderosa*).

Geology.

"With the exception of parts of the Cariboo and Snow Creek basins and a small area in the vicinity of Deer Park, the country examined may be said to be composed of granite. A number of different varieties of granite belonging to several distinct periods are represented.† Owing to the intricate manner in which they cut through each other, to the number of *facies* presented, and to the deformation to which in places they have been subjected, their separation and delimitation is often difficult if not impossible.

Gray granite.

"One of the commonest and most easily recognized rocks is the gray hornblende-biotite-granite, often characterized by large porphyritic crystals of felspar. This is the same granite as that typically devel-

* A list of the principal trees is given in the Summary Report for 1896. Further information may be found in the Annual Report, 1888-89, vol. IV. (N.S.), part B.

† These rocks vary considerably in composition, texture and structure, but for convenience will here be referred to as granites.

oped at Nelson and so many other west Kootenay points. It has already been described as newer than the stratified rocks there and also newer than the porphyrites. While in places the rock is uniform in grain, and phenocrysts are not observable, in others the felspar is porphyritic, sometimes on a very large scale, the crystals being from six to eight inches in length. When such large felspars, in perfect interpenetrating Carlsbad twins, stand chiselled out by surface weathering, this is a striking rock. When mechanically deformed, it becomes a typical augen-gneiss, and when its crushing has proceeded further it becomes a fine-grained, old looking gneiss that shows very little resemblance to the unaltered porphyritic granite. Such a gneiss is to be found near Robson.

Its extent.

"This granite extends from Robson to Cayuse Creek. A spur runs on through Deer Park and beyond, and along the Slocan watershed it extends north of the head of Deer Creek. An exposure of it was also seen on the lake, five miles above Deer Park, and a band several miles wide extends along the Lower Arrow Lake from Long Creek to the north edge of the area of the map-shet. At the head of Snow Creek and in the Valhalla Mountains, some isolated patches were noted.

Younger granite.

"Another rock that is frequently met with is a younger granite, characterized by the colour of its felspars, which are usually pinkish, reddish or brownish. This is also a biotite-hornblende rock that varies considerably in composition and structure. Intimately associated with this granite, so closely as often to be almost undistinguishable from it, is a still younger rock which shows a wider range of differentiation. Followed towards a contact, this rock acquires the structure of a porphyry, and along the border has a compact cryptocrystalline groundmass with phenocrysts of pink felspar embedded in it.

"These 'red granites' are extensively developed along the summit range. They also extend along Lower Arrow Lake from Deer Park to Long Creek. Dykes from them are very numerous in the older rocks.

Acidic granite

"At the head of Snow Creek and in the Valhalla Mountains, is an acidic granite, with felspar usually white or light-pink in colour. Quartz is usually abundant in the rock, while the bisilicates are only sparsely found, though some garnets are developed in it. It is usually fine-grained, non-porphyritic, with frequently-occurring pegmatitic *facies.* It is extensively cut by dykes of a pegmatite that contains muscovite, tourmaline and garnet. The pegmatite extends out from the parent mass and cuts the older rocks in the neighbourhood in the form of dykes. This granite is younger than the gray porphyritic granite. A rock that resembles it and which may prove to be the same, is

found on the Slocan slope, three miles east of the head of Deer Creek. It also contains muscovite-bearing pegmatites, and it is of course also younger than the gray granite.

"The relationship between these and the red granite was not clearly seen. Further study may show them to be closely connected with, if they are not parts of, the same eruption.

"Behind Robson and up Pass Creek, the granites contain bands and lenticular and irregular inclusions of gneiss. This gneiss is a fine-grained, old looking, often rusty rock, with acid and basic bands. The inclusions lie irregularly in the granite, their banding being often discordant with the gneissose structure of the granite. In the basic inclusions dykes of granite and pegmatite are pulled apart, broken and balled, giving it a pseudo-conglomeratic appearance. It is not known whether these gneisses represent inclusions of the old Shuswap gneisses or of the oldest granite of the Kootenay which is so closely associated with the Shuswap series. Detailed study may make it possible to further subdivide the granites of the district. Gneiss.

"All the granites are cut to a greater or less extent by dykes of the basic rock, which constitutes the latest observed eruption of the West Kootenay district.

"In the vicinity of Deer Park, the granites are replaced by sedimentary rocks, and by older and more basic eruptives, which appear to be augite-porphyrites and perhaps other greenstones. These rocks extend more or less continuously along the lake, from five miles up Cayuse Creek to a point about five miles above Deer Park. They are sometimes almost completely cut off by the granites, but re-appear at intervals between the points mentioned. The sedimentary rocks included in this area consist of crystalline limestones, phyllites and allied schists probably equivalent to Dr. Dawson's Nisconlith series (classified as Lowest Cambrian). These rocks are found close to and behind Deer Park. The limestones, which have the greatest areal distribution, extend in a band from two miles up Little Cayuse Creek to the lower Arrow Lake at Little Deer Park. Sedimentary rocks.

"The largest inclusions in the granites of this district, of other igneous and of sedimentary rocks, are on the upper portions of Cariboo, Snow and Trout creeks, behind Burton city. These rocks consist of mica-schists, grey gneisses and limestones, that may be referred to the Shuswap series; of dark argillites and phyllites of the Nisconlith series; and of dark banded calcareous and siliceous rocks similar to the Slocan slates of the Sandon region. These rocks are cut by old eruptives, some of which are altered so as to be only with difficulty dis- Inclusions in granites.

tinguishable from the Shuswap rocks. They are also cut by the granites and by the recent basic dykes. On account of the way in which the granite cuts into them, their actual boundary often cannot be determined. This is especially true of the Shuswap gneisses in the south and west, where they extend as innumerable little patches into the granite of the Valhalla Mountains.

East side of Upper Arrow Lake.

" The rocks on the east shore of Upper Arrow Lake are described by Dr. Dawson in the Annual Report for 1888-89, Vol. IV. (N.S.) p. 36 B. On the west side of the lake from the Halcyon Springs south the rocks are similar. To about opposite Cape Horn, the rocks are the glossy mica-schists, gneisses and interbanded limestones of the Shuswap series. From this point south they are mostly the dark Nisconlith argillites with numerous and large quartz veins. These rocks are much compressed, being in places folded into pitching anticlinoriums and synclinoriums. Some green and grey sheared rocks were also observed which may correspond to the Adams Lake series.

Glacial phenomena.

" In addition to the scoring and polishing of the rocks due to the agency of local glaciers, and the moraines which mark successive stages in the retreat of these toward the higher peaks, evidences of glaciation due to the great Cordilleran glacier are found at various places throughout the entire district. The striking features connected with these are the high altitudes at which they are found, and, notwithstanding the disturbing influences of the Valhalla Mountains and of the adjacent low Columbia and Slocan valleys, their general persistency in direction. The general direction of this striation is about S. 30° E., but local topography may influence it to some extent.

" Terraces of silts and gravels were observed at various places all along the Columbia slope from Burton City to Robson. While a few were seen above 4000 feet, more occurred in the neighbourhood of 3000 feet, and by far the greater number lay between 2500 feet and the present lake-level. One of the best marked and most persistent, which indicates rather a prolonged break in the gradual recession of the waters in which these silts were laid down, is found about five hundred to six hundred feet above the present level of the Arrow Lakes and Columbia or just about the elevation of the old wide valley of the Columbia. The general movements indicated by these and other phenomena, may account for some of the later faulting by which the mineral deposits have been disturbed.

Ore deposits.

" Portions of the district examined have been fairly well prospected, and many claims have been staked. But, although the surface indications in some instances are quite promising, little or no develop-

ment work of such a kind as to prove the extent and value of the ore-bodies, has as yet been carried out in this particular portion of the Kootenay district. The economic minerals have been found in veins in all the older rocks, from the gneisses and schists to the red granite. Wherever observed, the mode of origin of the deposits seems to have been the same. They occur in sheeted zones or bands of fracture in the country-rock, in the neighbourhood of white 'porphyry' dykes, with which they appear to be closely related. They are sometimes found along the edges of these dykes. It is probable that they were formed by hot mineral-bearing solutions which attended the close of that period of volcanic activity that resulted in the injection of the white dykes into the country-rock. These solutions, finding their way along the contacts in some cases, but more usually following the fissured zones in the country-rock as channels, percolated through it, and, meeting with changed conditions of temperature and pressure, deposited their load of vein-matter and metallic sulphides, replacing with this material the original country-rock. From the character of the deposits, it is to be inferred that they would be greatest where the nature of the rock afforded the readiest access to the mineralizing solutions. The lines of fracture being very irregular and very numerous, the mineralizing agent did not confine itself to any one or to the same ones. Sometimes the blocks of rock between fractures were entirely replaced by ore, sometimes they remain as 'horses' in the leads. The ore-deposits are consequently very irregular and cannot be said to have any confining walls; so that if any rule is to be applied to their exploitation, it is to follow ore. Earth-movements subsequent to their formation have caused faults and dislocations. While these are of various kinds, the amount of displacement is usually not great, and a careful study of the ground will generally reveal the direction of the slip. The character of the ore varies somewhat with the locality, but it usually consists of the minerals pyrrhotite, galenite, sphalerite, pyrite and chalcopyrite. In the Burton Camp some fahlore occurs in addition, and, it is stated, some tellurides.

Mode of occurrence.

"At Deer Park, during the season, development work was in progress on the Blue Bird, and on two or three other properties.

Development at Deer Park.

"On the Aaron's Rod, two and a-half miles back from the Needles, Lower Arrow Lake, a tunnel is being driven. At the time of visit it was 390 feet long.

"In the Burton City camp, several properties were active. A compressor was being installed at the Silver Queen in connection with the testing and opening up that property. Work was being continued at the Golden Hope, where a small force has been at work during the past

Burton City camp.

year. The main working is a tunnel 225 feet long. On the Millie Mac a force of men was engaged making preparations for active development.

'Big ledge.'

"An extensive deposit of sulphides known as the 'big ledge' occurs six miles back from the Upper Arrow Lake, opposite the Halcyon Springs. As no assay has as yet been made, it is not known if this deposit has an economic value. A tunnel six feet wide and twenty feet long on Walcott and Skea's claim, lay in solid sulphides consisting of pyrite, pyrrhotite, galenite, sphalerite and chalcopyrite. On the surface the ore is weathered to gosson or 'iron-cap' to a depth of three or four feet. As the surface is covered, and time could not be given to it, the extent of the deposit was not ascertained. Nineteen claims, all supposed to cover this lead, have been staked out.

"The main work of the season, as already noted, rendered it impossible to devote time to the examination of the mines actually in operation in different parts of West Kootenay, with the exception of those of the Slocan region, but a few notes on the latter, resulting from personal observations, may be of interest.

Slocan district.

"The past year has proved to be a prosperous one in the Slocan district, contrary to expectations in the early part of the season, when the Klondike excitement, together with depressed markets, threatened to retard its development. Increases in the prices of silver and lead had a stimulating effect, so that at the time of my visit, substantial if unostentatious progress was steadily being made. The development work, both in the prospects and mines, has proved very encouraging. That in the lower workings of the large mines has been particularly reassuring to those who entertained misgivings as to the permanency of the Slocan leads, for the depth gained on the Payne, Last Chance and other properties has exposed large bodies of high-grade ore, and has demonstrated the continuancy of the ore-bodies. This permanency was to be expected, such producers as the Ruth, Slocan Star and others, at comparatively low altitudes, showing that mineralization on a grand scale extended to horizons well down toward the bottoms of the valleys. That the majority of the best known mines should be located near the crests of the mountains, is to be accounted for by the fact that prospecting is there remarkably facilitated by the absence of superficial deposits and forest vegetation.

Mines at Sandon.

"The Payne has maintained or increased its large and steady shipments of ore, and its payment of excellent dividends. The lowest workings are now 700 or 800 feet below the upper tunnel, and the longest tunnel is about 1200 feet. The Ruth, which passed last year

into the control of an English company, has, under the new management, taken a place second only to the Payne as a producer. The Slocan Star is working steadily, maintaining its reputation as a dividend payer. Concentrating ore was being taken out at the time of my visit, but a large quantity of clean ore was blocked out ready for mining during the winter months, when lack of water makes it advisable to shut down the concentrator.

"At the Last Chance, some shipping was in progress, but until the tramway shall be completed, development work is that which is chiefly receiving attention. Large quantities of high-grade ore are ready to be taken out, and it is expected that as soon as the facilities for shipping are perfected this mine will rank with the heaviest producers.

"On the Noble Five, under the new management, attention has also been turned to development. This appears to be progressing favourably, and it may be expected that regular shipments from this property will soon be resumed. The Wonderful, Sovereign, Treasure Vault, Ajax and numerous other properties in the vicinity of Sandon have also produced more or less ore.

Mines on Howson Creek.

"In the Idaho Basin, the larger mines are working vigorously. The Queen Bess, now owned by the Queen Bess Proprietary Company, England, has become one of the heavy shippers. The Idaho-Alamo group continues to turn out large quantities of ore. Very high grade ore is being mined in the Idaho, some of it containing a large percentage of native silver.

General move in progress.

"Other mines besides these mentioned, in this and other parts of the district, are making favourable progress. The development work on a number of the prospects makes it probable that additions will be made to the list of shipping mines, and a number of new locations of considerable promise are recorded, so that, at present, the mining status of the Slocan is regarded as more satisfactory than at any previous time in its history."

Northern Alberta.

(With adjacent parts of British Columbia.)

Work by Mr. J. McEvoy.

Mr. J. McEvoy was engaged during the early part of the year in the construction of a topographical contoured map of a portion of the West Kootenay district, B.C., from surveys made during the previous summer.

Route through Yellow Head Pass.

Upon his exploration of the past season from Edmonton westward through the Yellow Head Pass to the Fraser and Canoe rivers, he reports as follows :—

Previous explorations.

"In the region surveyed during the last season, explorations had previously been made by Dr. (now Sir James) Hector, in connection with Captain Palliser's exploration of British North America, who, in 1859, travelled from Edmonton westward to the Athabasca River, which he ascended for some distance above Henry house. Several reconnaissance expeditions by the government surveyors engaged in examining lines for the Canadian Pacific Railway, were afterwards made along this route, and a final location survey was completed in 1876.

"Leaving Ottawa on the 24th of May and arriving in Edmonton on the 1st of June, the necessary supplies were obtained and the journey westward commenced on the 7th of June. The party consisted of : Wm. Spreadborough, (who, besides attending to other duties, made a collection of plants) ; with F. A. Jackson and S. Derr, as packers. Besides the above-mentioned, Mr. R. G. Hardisty was engaged to transport the bulk of the supplies as far as Henry house.

Lake St. Ann.

"A wagon-road leads through a good farming country as far as Lake St. Ann, crossing and recrossing the Sturgeon River several times on the way. Lake St. Ann is shallow, about three and a-half miles wide and eight miles long, to the Narrows, north of which it is reported to widen out again to a still larger body. At the Hudson's Bay post there, in charge of Mr. Taylor, to whom I am indebted for courteous assistance, the arrangement of packs was completed and a full complement of horses was secured.

"Leaving Lake St. Ann on the 11th of June and travelling southwestward *via* Island Lake, the Pembina River was reached on the 13th. At Island Lake is Pierre Grey's trading-post, the farthest outlying settlement on the route that is permanently occupied, with the exception of Swift's at Henry house.

Pembina River coal beds.

"The Pembina River is about eighty yards wide, and at the time of our visit was quite shallow and easily fordable. Earlier in the spring or during a rainy season, it is so deep as to necessitate swimming horses. Several outcrops of coal occur on the banks of the river, principally above the crossing. The coal has been on fire here years ago, and the overlying beds of clay and shale have fallen in, giving a very disturbed appearance to the locality. The white clay is partly burned to a pale red terra cotta. Half a mile above the crossing, on the east side, a seam of coal 17 feet 10 inches thick is exposed, of which the upper four feet is impure. On the opposite side there is a seam

13 feet thick, having four small partings of clay and carbonaceous shale, amounting in all to nine inches. Two small seams separated by carbonaceous shale and clay overlie this.

Erosion of Pembina valley.

"The valley of the Pembina is 250 to 300 feet below the level of the surrounding country and gives evidence of a greater amount of erosion than would be expected from the volume of water. A possible explanation of this will be given later, based upon what was seen at the mountains near its source.

Pembina River to McLeod River.

"Beyond the Pembina, the route ascends quickly to the level of the surrounding country, which, away from the immediate vicinity of the streams is flat, and it continues westward, crossing the Lobstick River, a tributary of the Pembina locally known as Buffalo-dung River, at a point where its valley is only fifty feet deep. Further westward, the route crosses a gradually rising country that slopes gently northward toward the Lobstick River. The small tributary streams make very little impression on the surface, and no rock-exposures are to be found, in fact none were seen all the way from the Pembina to the McLeod River. The characteristics of the route are, thick small timber, the greater part of which has been killed by fire, and windfall, frequent bog-holes and deep sticky mud with several bad muskegs. As few persons who travel this way ever cut a stick if they can get around or jump over it, it can readily be understood that, especially in a wet season, the so-called trail is all but impassable. The old trail made in connection with the government railway explorations of 1874-76, is still distinguishable in places but is of little service. The corduroy laid down at that time across the muskegs and swamps is now in such a bad state of preservation as to be unsafe for animals.

"Before reaching the McLeod River, two of its tributaries, Wolf Creek and Moose Creek were crossed. The former is a considerable stream heading with a branch of the Pembina River. Between these two streams the trail runs along a sand-ridge trending N. 65° W.,* nearly two miles in length, bending toward its western end to S. 70° W., with several spurs turning off N. 55° E. The width of the ridge is fifteen to thirty yards, its height five to forty feet and the elevation above sea about 2900 feet.

McLeod River.

Two and a-half miles beyond Moose Creek, the McLeod River was reached and crossed. It is 110 yards wide and at that time (June 19th) not more than two feet deep at the ford; although the volume of water is far greater than that of the Pembina its valley is comparatively shallow, being only 90 to 100 feet deep.

* Bearings refer to the true meridian, but it must be understood that both bearings and distances are here given subject to correction.

"Following the north bank of the McLeod, the Big Eddy is reached in seven miles. Here the river takes a semicircular bend to the south, while the trail, continuing westward, joins it again at White Mud Creek, a distance of ten miles. A large tributary called by the Indians, Stick River, which rises near the base of the mountains, joins the McLeod at the southern point of this bend. From White Mud Creek, the trail follows the river thirteen and a-half miles further, to a point formerly known as Plum Pudding Cache, now called the Leavings. Rock exposures are not frequent on this part of the McLeod, but where seen consist of coarse, gray and yellowish-gray sandstones, clayey sandstones, false-bedded, carbonaceous shale and small seams of lignite. They are of Laramie age and probably represent the lower division of that series.

McLeod-Athabasca watershed.

"At the Leavings the river bends southward, while the trail continuing to the west crosses the watershed to the Athabasca River. This watershed is a slightly rolling country, rising gently to a height of 940 feet above the McLeod or 1340 feet above the Athabasca. In a straight line, the distance between the rivers is only about ten miles. The trail, however, turns south-westward from the summit and reaches the Athabasca at a point twenty miles distant from the Leavings of the McLeod. All this country has been overrun by fire a few years ago and much of the timber destroyed was of merchantable size.

Climate.

"The climate of the country so far passed over, is decidedly wet, but as the bottom of the Athabasca valley is approached evidences of a change become apparent, such as smaller and more scattered timber, steeper slopes on the side-hills and cut-banks of streams, and a marked difference in the vegetation. The difference is more noticeable farther up the river, and is most pronounced from Jasper house to Henry house.

Lower Laramie fossils.

"Near the mouth of the small stream named Sandstone Creek, down which the trail descends to the Athabasca, in an exposure of gray and carbonaceous shales, and gray and yellowish sandstones, some fossils were obtained. Mr. Whiteaves, in a preliminary examination of these, finds that they correspond with the fossils found elsewhere in the Lower Laramie rocks.

"Four miles farther up the Athabasca, at a place known as Nc-kas-pe-kwat (corrupted into Cache Pecotte), a branch route turns northward, crossing the river and leading to the Smoky River. This part of the Athabasca valley is, to a great extent, an open grass country, with some light, second-growth timber. The slope of the south-west side of the valley is very gentle, and at a distance of a mile back the

elevation is not more than a hundred feet above the river. The same characteristics continue up to Prairie Creek, a distance of five miles further. Here the first evidence of the disturbance connected which the uplift of the mountains is seen. Greenish sandstones interbedded with black shales, etc., holding small, irregular seams of lignite, are found, striking N. 80° W., and dipping to north and south at angles of 70° to vertical. These rocks may represent the Pierre shales and Fox Hill sandstones.

Pierre shales and Fox Hill sandstones.

"As yet there is no approach to a mountainous condition, as notwithstanding the evidence of great folding in the rocks, the hills in the vicinity of the river nowhere rise more than 400 or 500 feet.

"Just above the mouth of Prairie Creek, the river bends to the westward for a distance of eight miles, where it issues from Brulé Lake. This lake is an enlargement of the river about seven miles long and half a mile to a mile in width. The trail does not follow this detour of the river, but ascends Prairie Creek nine miles, then turns south-westward across Drystone Creek to Fiddle Creek, which flows into the Athabasca at the head of Brulé Lake.

"As Prairie Creek is ascended, the ridges that run at right angles to its course become more elevated, and between Prairie Creek and Drystone Creek rises the first foot-hill of the Rockies. The limestones make their appearance here to the north-eastward for the first time, in a sharply folded anticline, slightly overturned. On the opposite side of the river, in Bullrush Mountain, the limestones have apparently been similarly folded, but afterwards disturbed and broken by a thrust from the south, resulting in at least two lines of fault. The principal rocks here are fine-grained gray and bluish limestones, and with these are associated thin-bedded yellowish-weathering siliceous and calcareous shales, dark flaggy limestone and carbonaceous shale.

Limestones.

"It would be unadvisable in this preliminary report to make any statements in detail as to the age of these rocks, as the season's work has not yet been plotted, nor have the fossils been critically examined. There is, however, a great thickness of rocks exposed in the Athabasca valley, comprising blue and gray limestones, magnesian limestones, frequently unequally hardened and holding cherty layers, quartzites more or less dolomitic in parts, with some yellow shale and carbonaceous shale. Carboniferous and Devonian beds are represented and also, probably, some Cambrian rocks corresponding to the Castle Mountain Group of Mr. McConnell. The rocks occurring in the first foot-hill mentioned above, very probably represent the Banff Limestones.

Formations represented.

"From this point upward, high, rugged mountains stand up boldly on each side of the valley, with vertical cliffs and steep talus-slopes,

leaving a flat-bottomed valley one to two miles wide through which the Athabasca winds, seldom in one united stream but lost in a network of sloughs. The most notable feature is Roche Miette, a bare rock-promontory with a vertical face, standing on the east side of the valley just below Jasper Lake. The timber-line is low, trees being seldom found above 6000 and frequently dying out at 5500 feet, the limit in each case being largely determined by the sheltered or exposed nature of the situation. The general aspect of the mountains is rugged and barren, the slopes being too steep in most parts to support a growth of trees.

Roche Miette.

Lateral valleys in pairs.

"The strike of the rocks is from S. 60° E. to S. 70° E., and the confluent streams having the same direction are generally arranged in pairs, each pair occupying one continuous valley, crossing the main valley approximately at right angles. A notable example of this is found in the case of Rocky and Stony rivers (the latter originally Snake Indian River), which join the Athabasca near the site of Jasper house at the foot of Jasper Lake.

Jasper Lake.

"Rocky River, where crossed near the mouth, is divided into ten separate channels and was barely fordable at the time. Jasper Lake is about six miles long and a mile in width. Its eastern shore is formed by a narrow sand-ridge, thirty feet high and fifty yards to a quarter of a mile in width. On the other side of the ridge and extending to the base of the hills are two smaller bodies of water known as Fish Lakes. The present form of this ridge is entirely due to the action of the wind, drifting up the fine silty sand from the beach and dropping in on the top. The same action is going on along the banks of the river higher up the valley and was also noticed on the east shore of Brulé Lake.

Sulphuretted water.

"Several springs of sulphuretted water occur in this part of the valley, the largest seen being on the east side about three miles above Jasper Lake. A stream of cold bluish-green water, three feet wide and four inches deep, smelling very strongly of sulphuretted hydrogen, comes from under the dolomite rocks, leaving a deposit of native sulphur in its channel.

Under ground passage of Maligne River.

"A few miles above Jasper Lake, the Athabasca bends slightly towards the east, and continues in that direction to the site of Henry house, receiving the waters of Snaring River from the west on the way. At Henry house the Maligne River flows in from the east. It is a swift stream, fordable only at very low water, and possesses no remarkable features for the first mile and a-half above its mouth. It then comes from a narrow winding gorge fifty to a hundred feet deep and fifteen to thirty feet wide. The rocky walls of this chasm have partly

closed over and in places are almost touching, boulders lodged in the crevice preventing them from closing altogether. This is partly due to a fracture in the rocks at one side. On reaching the level of the valley above the gorge, 350 feet above the Athabasca River, it is seen that the volume of the stream is only about one-eighth of that below, and it is evident that the main supply of water comes through underground passages.

Cross the Athabasca.

"Mr. Hardisty set out on his return to Edmonton on the 4th of July with the twelve hired horses. The remainder, with all the outfit, were across the Athabasca on the 5th. The river is swift and narrow at the crossing place, just below the mouth of Maligne River. About half the provisions were stored at Mr. Swift's cabin on the west side, two miles and a half below the crossing, and the westward journey was resumed on the 7th.

Faulted contact with Bow River series.

"Three-quarters of a mile above Henry house, the Devono-Carboniferous limestones are cut off by a fault, and notwithstanding the great thickness of these rocks no trace of them was found on the route west of this. The rocks brought into contact with the limestones by this fault, are hard, fine-grained conglomerates or coarse quartzitic sandstones. Some of these conglomerates hold pebbles up to half an inch in diameter of pinkish, milky, and semi-transparent quartz, the whole very closely resembling the conglomerates of the Bow River series. Associated with these conglomerates and underlying them, a short distance to the south, on the Miette River, are fine-grained conglomerates which have been squeezed out to a schist, with a great development of fine pale mica. Interbedded with these are fine-grained gray and greenish-gray schists with thin slaty cleavage. The course of the Miette River, which comes from the Yellow Head Pass and empties into the Athabasca five miles above the Maligne, follows approximately the summit of a broken, anticlinal fold of these rocks.

Miette River.

"Ascending the Miette River, the trail follows the rocky ridges near the stream and through windfalls of small dead pines for a couple of miles, then descending to the river-flat, it crosses the stream four times in a distance of three miles, in order to avoid steep rocky banks. The animals have to swim at the lower ford, except at low stages of the water. Ten miles up, the river-bottom widens and the stream takes a winding course through marshes and meadows half a mile and more in width. The valley continues of this character to within a mile of the pass, the main water supply having in the meantime been received from the lateral valleys.

Yellow Head Pass.

"Miette River is crossed for the last time at a point, where the channel is blocked by log jams and the stream is divided into several

branches running among the trees. When the last of these branches is crossed it is suddenly realized that the summit of the Yellow Head Pass has been crossed, as at high stages some of the water empties by this branch into the Fraser watershed. The elevation of the summit of the pass is 3733 feet above sea-level, according to the railway survey. It is distant eighteen miles in a straight line from, and is 400 feet above, the Athabasca River.

Valley west of summit.

"From the summit, the route follows the bottom of the valley in a south-westerly direction, inclining gently downward to Yellow Head (or Cow-dung) Lake, distant two miles and a-half and 100 feet below the pass. Yellow Head Lake is a narrow body of water about five miles long and half a mile in width. The route follows the north-west shore, passing through a thick windfall of heavy timber on the way. A small stream, a mile in length, carries the waters of this lake into the Fraser River, which is here a large, rapid, muddy stream unfordable at this season.

Rocks seen in the pass.

"Throughout the pass, in the bottom of the valley, exposures continue of gray, rather fine-grained schistose conglomerate, with greenish-gray smooth schists and blackish argillites, while the mountains which stand on each side of the pass behind intervening foot-hills or ridges, show, overlying these rocks a great thickness of fine-grained gray quartzites, having below them, 150 feet or more of light-gray coarsely crystalline dolomite. A mountain on the north side of the pass was ascended to examine these rocks and to obtain topographical sketches.

Fraser River valley.

"The valley of the Fraser, down which the trail now proceeds, is wide and partly free of timber. The river hugs the base of the steep mountain-side to the south, leaving a gently rising slope on the north, half a mile or more in width. A few miles down, the timber becomes larger and thicker and at a distance of twelve miles from the pass the first of the recently burnt country begins. The burnt forest continues almost without interruption to Tête Jaune Cache, the greater part of it having been set on fire early this season. Fourteen miles from the pass a large stream called Grant Brook flows in from the north. It is about fifty feet wide and very swift. A mountain on the west side of this stream and north of the Fraser was visited, and showed gray quartzites, crystalline dolomite and some white crystalline limestone, with, overlying these, dark-blue flaggy limestones and yellowish and greenish-gray schists. The direction of the Fraser in this part is along the strike of the rocks. Two large tributaries come in from the south besides numerous smaller ones.

"Moose River is three miles below Grant Brook. It is a rapid, muddy stream 150 feet wide, and fordable except at very high water. The head of Moose Lake is two miles and a-quarter below the crossing of Moose River. The lake is eight miles and a-half long, and a mile wide near the east end, narrowing gradually toward the west. Another large tributary from the south flows in near the head of the lake. Much valuable spruce timber has been destroyed by fire in this part of the valley.

Destruction of timber.

"The Fraser River, issuing from Moose Lake, continues its westward course, moving slowly along in a wide stream for two or three miles, when it narrows, and taking a steeper grade, hurries rapidly downward. Fourteen miles below Moose Lake, the first of two large northern tributaries, a mile and a half apart, joins the Fraser. This is a shallow stream 100 feet wide, with a moderate current flowing past the base of Robson Peak, an exceptionally grand mountain standing about five miles north of the Fraser. A rough calculation makes the height of this peak 13,500 feet above sea-level, which shows it to be the highest known point in the Rocky Mountains north of the International boundary. These streams were collectively known as the Grand Forks of the Fraser River. The western tributary, now commonly known as Swift-current River, is an erratic, turbulent stream, fed by glaciers. It may sometimes be forded without difficulty in the morning, and by evening be utterly impassable.

Highest known peak in Rocky Mts.

"A mountain standing between these streams, shows schistose conglomerate interbedded with soft greenish-gray schist, and, near the top, layers of dark, flaggy limestone and gray and black argillite.

"A little above this point, the Fraser River changes its former direction of N. 65° W. to that of S. 60° W., and continues in the last-mentioned direction to Tête Jaune Cache, cutting obliquely across the strike of the rocks. From Swift-current River to the Cache is ten miles, and in the latter part of this distance the valley narrows noticeably, the river being confined by high gravel banks, and near the Cache, by low rocky bluffs.

"At Tête Jaune Cache, the Fraser emerges into the great valley which is the most important feature of the western mountainous country. A good description of this valley, with particular reference to another part of its length, is given by Mr. McConnell in the Annual Report for 1894 (pp. 18-19c). The bottom of the valley is here four to five miles wide and very level. Having a dry climate it is covered with only a light growth of pine trees. So well are its main characteristics preserved throughout, that here there is a striking resemblance to

Great valley at Tête Jaune Cache.

that part of it seen near Donald, on the Canadian Pacific Railway. It deserves a name of more than local descriptive significance.

Cranberry Lake.

" The Fraser now bends to the north-west down this valley, receiving a tributary, the McLennan River, from the south-east. The McLennan takes its rise in a shallow lake in the main valley, called Cranberry Lake, distant fifteen miles from the Fraser and having an altitude of 2622 feet, but acquires most of its water from the adjacent mountains. It is only three-quarters of a mile from Cranberry Lake to the Canoe River, which comes in from the south-west and flows down the main valley in a direction opposite to the Fraser.

Change in rock-series at the great valley.

" Seven mountains in this vicinity were visited, four on the east side and three on the west of the valley. It is evident that the valley not only marks a great division in the topography, but also forms a dividing line of geological importance. On the east side, the first rocks met with are conglomerates, now squeezed so as to assume the outward appearance of coarse mica-schist. These are overlain, near the summits, by undulating folds of black argillite and yellow schists, including beds of dark flaggy limestone, yellow, finely crystalline, dolomitic limestone and talc. The former of these probably correspond with the Bow River series, and the latter with the Castle Mountain group of Cambrian age. The western side is composed entirely of rocks not met with previously on this exploration. They consist of garnetiferous mica-schists and gneisses, with some blackish micaceous schists and light-coloured gneisses that represent a foliated granitoid rock. The garnet-mica-schist is the predominating rock. In some places it is made up almost entirely of mica and garnet. These rocks, although differing somewhat from the Shuswap series as seen further south, are pretty certainly referable to that series. They hold numerous veins of coarse pegmatite, which, besides the ordinary constituents, contain tourmaline, garnet, cyanite, beryl and apatite.

Shuswap series.

Bonanza mica mine.

" On one of these veins the Bonanza mica claim is located, seven miles south of Tête Jaune Cache, 5300 feet above the level of the Fraser River. The vein is about fifteen feet wide, where an opening has been made, dipping S. 45° W. conformably with the country-rock. Its continuation toward the north-west is covered with talus from the mountain, while on the south-west side of the opening the original top of the deposit is seen covered by the mica-schist. At the time of our visit, Messrs. S. Winter and J. F. Smith, with a party of ten men, were engaged in taking out and cutting mica intended for shipment by pack-horses to the nearest railway point. The quartz, felspar and mica are separated into large masses, the crystals of mica being frequently eighteen inches long and eleven inches wide, and are found

in greatest abundance near the hanging wall. It is evident that the mass was cooled at a great depth and very slowly to permit of this amount of segretion. While practically no work has been done with a view of proving the extent of the deposit, it may reasonably be expected, from what actually appears, that a large quantity of mica can be obtained here. The mica is a transparent muscovite with a very light-greenish cast and is otherwise of excellent quality. The probabilities of further important developments appear to be very favourable.

" Another claim, owned by some Edmonton miners, is situated a few miles south-east of the Bonanza. Fifteen miles to the south-east on the mountains, near the head-waters of Canoe River, several claims have also been staked. On one of these some work is reported to have been done, exposing a deposit of marketable mica. It may be expected that further discoveries of valuable mica deposits will be made in these rocks, which are of the same character for a distance of twenty miles at least, and probably much further.

Necessity of trails.

" A great hindrance to the development of this or any other mining industry in this part of the country, is the difficulty of travelling without proper trails. It requires seventeen to twenty days to reach Tête Jaune Cache from Kamloops, a distance of 215 miles, in the present state of the trail. From Edmonton to the Cache, a distance of about 350 miles, requires ordinarily twenty-five days, but in a very favourable season the distance might be covered in twenty days. It will thus be seen that, apart from the question of shipping out the products of the mines, the greater part of the short season available is wasted in travelling to and fro. A moderate sum of money if properly expended on these routes, would put them in a fairly passable condition.

Quartz veins.

" The rocks of the Shuswap series, mentioned above as occupying the south-western side of the great valley, do not carry gold, but on the other side colours can be obtained in most of the tributary streams. On the mountains about seven miles from the Cache, in the rocks before mentioned as probably corresponding to the Castle Mountain group, numerous quartz veins were observed. Where these were noted, the cleavage of the rocks dips south at high angles, while a secondary vertical cleavage or jointage runs north-and-south. The larger and more numerous quartz veins run parallel to this secondary cleavage, and have a thickness of from one to five feet, while smaller lenticular veins follow the principal cleavage. These veins show a good deal of oxidized iron-pyrites and some galena. The galena proved to be argentiferous.

Argentiferous galena.

"Quartz veins are to be seen in many places along the route, all the way from this place to the Athabasca River. On the Miette River, the rocks are frequently marked with a reticulation of small veins of white quartz. Sometimes these reach a width of two feet and over, and claims have been located there from which assays of eight dollars per ton in gold are reported. Colours of gold can be obtained in several places on the Miette River. At the faulted junction of the limestones and conglomerates, near Henry house, galena was noted in a small vein.

Gold on the Miette River.

"On the return journey, some further work was done on the north side of the Fraser valley above Moose Lake, to ascertain the position of a band of rusty quartzite which weathers out to a brilliant red colour. Viewed from a distance, these mountains have a gorgeous appearance of red and yellow, and suggest the name of Rainbow Mountains.

"Returning to Swift's place, near Henry house, on the 1st of September, the provisions that had been stored there two months previously were found all safe, and we were further indebted to Mr. Swift for exchanging a quantity of them for others that were more required. The next two weeks were spent in collecting fossils and in tracing out the complicated faults and folds of the rocks previously mentioned along the Athabasca River.

Jasper Lake to Brazeau River.

"On the 14th of September, the Athabasca was again crossed, and having moved down the river as far as the head of Jasper Lake, the exploration of a route through the mountains to the head of a branch of the Brazeau River, was commenced. The route selected was one that had been travelled by the Indians many years ago, previous to the railway exploration of 1874. Ascending a small stream called Jack Creek, that flows into the Athabasca above Jasper Lake, and travelling in a direction S. 60° E. over three minor summits of 5500 to 6000 feet, the route then turns northward into the valley of Rocky River. It reaches this river at a point distant sixteen miles and a-half from its mouth in a straight line. The valley of the river is remarkably straight, following the strike of the rocks, and is shut in by high wall-like mountains on each side. At a distance of fifteen and a-half miles further up, the river forks, the greater part of the water coming in from the southern branch. Following the other branch, which has a general direction of S. 65° E., the summit is reached in a further distance of thirteen miles, the route, for a great part of the way, being along the stony bed of the stream. The altitude of the summit is about 7500 feet.

"The branch of the Brazeau on the other side, descends rapidly, but without any cañon, and bending northward, at a distance of thirteen

miles from the summit it emerges from the mountains into a plateau country of about 5000 feet elevation. Three miles east of this place, the main branch of the Brazeau, which heads with the Athabasca River near Brazeau Lake, also comes out of the mountains.

"The rocks met with on this route are the same as those seen between Jasper house and Brulé Lake. Their attitude at the edge of the mountains, is, however, very different from that on the Athabasca. No folding or crushing is to be seen, but a straight uplift without contortion of the beds and apparently without overthrust, for although the talus from the limestones obscures the line of contact with the Cretaceous sandstones, these rocks are both found in place in the bed of the stream in positions that preclude the possibility of a lateral movement of any extent.

Uplift of mountains on Brazeau River.

"It was then decided that to return north-westward, near the base of the mountains, and to descend the McLeod River, was likely to yield more new information than could be gained by following the more direct route down the Brazeau and North Saskatchewan rivers. Accordingly, an old Indian trail leading in the required direction was followed. It traverses a level country, having an elevation of 5000 feet above the sea and strongly marked by terraces of round coarse gravel composed of limestone and quartzite materials. A low range of hills eight to ten miles to the north-east, through which the Brazeau River has since cut its way, at one time evidently held in a body of water here. Another branch of the Brazeau, nine miles from the one just left, was crossed, and six miles farther on the most northerly branch of that stream comes from behind a long range of foot-hills having an elevation of about 6500 feet. It seems probable, from the extent of the erosion in the Pembina valley lower down, that, at least part of the drainage from the mountains now emptying into the Brazeau, at one time found its way into the Pembina River which lies a few miles to the north.

"At this crossing of the Brazeau, there is an exposure of yellowish sandstones and black carbonaceous shales, with several small seams of coal, one of which has a thickness of three feet. The Indian trail forks at this place, one branch descending the river and the other following it up into the foot-hills, so a middle course across country was adopted, and the Pembina River, here a small stream, was shortly reached. Up to this time the country traversed has a dry climate, owing to the effect of the Chinook winds, but now, as the distance from the mountains had been gradually increasing, the effect of a greater amount of moisture was noticeable and muskegs and swamps became numerous. The result of a great fire which overran the country between here and

Pembina River.

the Athabasca River has, on the whole, up to the present time at least, been to make travelling less difficult.

"The first rocks met with on the Pembina River were dull olive-green sandstones and shales striking east-and-west, vertical. Further down the river the rock consists entirely of soft slate-gray shales, containing rounded and lenticular nodules of grey ironstone, sometimes cherty. As the river is descended, the dips become undulating and lower, until at nine miles down, the rocks are almost horizontal. These rocks closely correspond with the Pierre division of the Cretaceous.

Pierre shales.

Upper part of McLeod River.

"It is only three miles from here, across low hills, to the source of a stream flowing westward into the main branch of the McLeod, and five miles down this stream the first exposure of yellow sandstones of the Edmonton or Lower Laramie series, was found. The McLeod was reached at a point distant three days' travel from the Leavings. As the river is descended, numerous separate exposures are to be seen in the banks, showing irregular, coarse, yellowish sandstones, interbedded with clayey sandstone and blackish carbonaceous shale. One seam of coal was noted, six inches to a foot in thickness. Other larger seams are reported to occur higher up the river. Some prospecting has been done on the McLeod in which a certain amount of gold was obtained. It is found chiefly in a small seam in the river-gravels principally composed of dark materials derived from the shales.

"The return journey occupied eleven days from the Leavings to Edmonton, which was reached on the 14th of October.

Natural facilities of route.

"The natural facilities of the Yellow Head Pass as a route through the mountains, has been made known by the reports on the railway location line run for the Dominion Government, but perhaps sufficient weight has not been given to the fact that this route is entirely free from snow-slides. The importance of this fact can now be more fully appreciated on account of the great cost of the construction and maintenance of snow-sheds, since experienced in railway work. It may also be worthy of note that this pass affords an easy means of access from the North-west to the great valley previously mentioned, which forming as it does such a good natural highway, should eventually become the chief route for communication between north and south. The advantages of the route for a wagon road are even greater than for a railway, as in making such a road no rock cutting would be necessary.

Glacial drift.

"West of Edmonton, the country is generally deeply drift-covered, showing boulders of Laurentian rocks as well as of gray quartzites from the Rocky Mountains. At Lake St. Ann, besides these drift

materials boulders of yellowish-gray limestone holding Devonian fossils are numerous, with a few of coarse purplish-red quartzite or grit. Laurentian boulders are found to occur westward nearly to the McLeod River, beyond which all the drift material has come from the mountains. The surface deposit is generally a yellowish-white sticky clay, impervious to water, and to this is largely due the extensive muskegs and swamps that characterize the route. The long eskers before mentioned, occurring east of the crossing of the McLeod River, are a notable exception to the general rule. No limestones from the mountains were noted east of the McLeod.

"Along the valley of the Athabasca River in the mountains, exposures of boulder-clay are found in the lateral valleys, mostly composed of local material but containing also many travelled boulders of quartzite. On the east side of the river, above Henry house, a terrace 600 feet above the river is composed of silty calcareous boulder-clay. Traces of this deposit are found along the Miette River, and westward beyond the pass silty terraces, less calcareous in character and for the most part free from boulders, are extensively developed along the Fraser River. The western limit of the silt deposits on the Fraser is a few miles above Moose Lake. White silt deposit.

"On the higher summits of the mountains, no trace of glaciation could be discovered. East of Tête Jaune Cache, at an elevation of about 7300 feet, heavy glaciation was noted running S. 25° W., an occurrence difficult to explain. A mountain north-east of Camp River, about 8300 feet above the sea, has the general smooth aspect of a glaciated summit, but no striæ or travelled boulders could be found. Glacial striæ.

"The distribution of the principal trees is given in the following short notes:—Black and white spruce, poplar and cottonwood are found generally throughout the whole country traversed. Larch (*L. Americana*) extends as far westward as the McLeod River and ascends that river forty miles above the Leavings. It was not seen on the Athabasca or westward. Black pine (*P. Murrayana*) first seen thirty miles west of Edmonton, continues throughout. Douglas fir commences three miles below Jasper house and continues westward. The eastern "balsam" (*Abies balsamea*) was first seen on the Athabasca River, while *A. subalpina* was found generally throughout the mountains. White pine (*P. monticola*) was seen at Moose Lake on the Fraser River. White stemmed pine (*P. albicaulis*) was on most of the high mountains. Cedar and Hemlock (*Tsuga Mertensiana*) came in a few miles below Moose Lake and continue westward. Yew is found on wet mountain sides on the Fraser and Canoe rivers. Engelmann's spruce was found generally throughout the mountains, and another Distribution of trees.

form seen is probably that noted by Prof. Macoun as intermediate between this and the white spruce. Lyell's larch does not occur on the mountains in this district. Canoe-birch was first seen on the Athabasca River and continues westward.

Agricultural and grazing lands.

" One of the important resources of the region explored this season will be its agricultural and grazing lands. Farm settlements are at present to be found as far west of Edmonton as Island Lake near the Pembina River. Beyond that point, with one notable exception, no attempt at cultivation has been made. The exception referred to is a ranch three and a half miles below Henry house on the Athabasca. Mr. Swift has here demonstrated that the country is capable of producing wheat, potatoes, and various kinds of vegetables. On September 1st, he had harvested a crop of two varieties of good hard wheat, and his potatoes were good, both in size and quality. A great part of the bottom land of the Athabasca valley would yield good crops. There is an abundance of good grass all along the route from Edmonton to the pass, more particularly in the vicinity of the streams, and a wide belt of good pasture-land extends along the base of the mountains to the south. The country generally is capable of supporting a large amount of stock. Horses are wintered out successfully on the Athabasca River and at other places.

" In the wide bottom of the great valley passing Tête Jaune Cache, there is some good soil, and it may be safely said that one-fourth or more of its area would make rich farming land. A considerable portion of this is free from timber and covered with luxuriant grass suitable for making hay.

Collection of plants.

" Mr. Wm. Spreadborough, made during the season a collection of the flowering plants which, I am told by Prof. Macoun, includes nearly all the species supposed to grow in the region examined. Several species were found which had not been collected since Drummond's time and two or perhaps three species new to science were secured. One of these, *Viola cyclophylla*, has since been described by Dr. E. L. Greene. In all about 525 species of flowering plants and some cryptogams were collected. The range of several species has been extended, and a number of plants previously known from the lower Columbia, but not found in the southern Rocky Mountains were collected on the Canoe River and on the head-waters of the Fraser River. This is due to the continuity of the great valley, so often referred to in this report, not only affording an easy means for these plants to extend, but also causing a congenial temperate climate to enable them to hold their ground."

ONTARIO.

Mr. W. McInnes, in the early part of 1898, was engaged in plotting and compiling the surveys of the preceding summer and in work upon a general report upon the region covered by the Seine River and Shebandowan map-sheets, already printed. Mr. McInnes left Ottawa on the 13th of June, with instructions to make a geological exploration of the country lying to the north of the Seine River sheet, of the series of geological maps of western Ontario and to the east of the Manitou sheet. This also involved the making of such surveys as were necessary to the compilation of an accurate topographical map of the district. The amount of surveying work which was required was too great to allow of completion of the map-sheet in one season, but about half the area was covered during the summer. Mr. H. L. Smith, who had been nominated to assist Mr. McInnes, accompanied him and satisfactorily performed his duties during the season. On the work accomplished Mr. McInnes makes the following report.

Work by Mr. W. McInnes.

Ignace sheet Rainy River District.

"After outfitting at Rat Portage, the season's work was begun at Dinorwic on June 19th. A micrometer survey was started at a point on the south-west arm of Lake Minnitaki about ten miles north of the crossing of Niven's fifth meridian line, and connecting there with last season's surveys. A continuous survey was made of the south shore of the lake to the inflow of English River and of English River with the lake-expansions along its course to Bear Lake, and thence to Ignace station on the Canadian Pacific Railway, by way of Sand Point Lake.

Lake Minnitaki.

"The shore of Minnitaki throughout the whole extent traversed, lies within the Keewatin system of rocks, though it is nowhere more than three miles to the north of the northern edge of the Laurentian granites and gneisses. All along the shores of the long, narrow, south-westerly bay, from the crossing of Niven's meridian line north-eastwards, the rocks exposed, are in the main massive diorites and diabases with areas of green schist which may probably be considered as crushed and sheared phases of the massive basic rocks. Associated with these basic rocks are areas, more limited in extent, of acid quartz-porphyries and the schists derived from their shearing. Often the quartz-porphyries are still quite massive, and in places they approach very closely ordinary granites. They are seen in places to clearly cut the green schists.

South-westerly bay.

"The strike all along closely follows the general trend of the shore-line, the curve of the latter, from a little east of north to a little north of east, being apparently determined by the strike of the schists. The

next bay, which in direction is closely parallel to that just described and is separated from it by a dividing ridge only half a mile to a mile and a-half in width, shows along its north shore the same set of diorites and green schists, with bands of felspathic schists and quartz-schists similar to those above referred to.

"The south shore of the bay is occupied by massive quartz-diorites and even-grained, hard, grey quartzites in which is developed in many places a rough schistosity striking parallel to the trend of the shore-line. Going southerly from the south shore of the bay and following up-stream a route leading to Kapikwabikok Lake, this band is crossed at about right angles to the strike and is found to give place, at a distance of about three-quarters of a mile from Lake Minnitaki, to basic green chloritic and hornblendic schists and massive diorites, that continue to the northern edge of the Laurentian. On Kapikwabikok and the lake lying between it and Minnitaki, are several small areas of hornblende-granite, biotite-granite and biotite-gneiss, that have the aspect of intrusives in the schists, which they invade in the form of long arms, and blocks of which they inclose. These represent, almost without question, outliers from the main granitic area which comes close to the southern end of the lake, and is at no great distance from the east shores of both Kapikwabikok and the lake to the north of it. Some of the areas may, very probably, be connected with the main mass, but the connection was not established.

Kapikwabi-kok Lake.

"All along the main south shore of Minnitaki, to within about five miles of the outlet of Twin Lakes, massive felspathic quartzose rocks, probably quartzites, and their derived schists, form the shore, striking nearly east-and-west. For the next five miles, or nearly to Twin Lakes, the more basic schists and massive rocks are seen.

Twin Lakes.

"The greater part of Twin Lakes is occupied by the quartzites, the southern end of the lake extending into the diorites, which here again lie to the south of the more quartzose rocks and between them and the granites. Continuing along the main shore of Minnitaki, the quartzites extend beyond the point where the shore-line bends abruptly to the south, for about a mile down into the southern bay. The remaining shores of this bay lie altogether in the basic division, its extreme southern end reaching down to within a mile and a-half of the northern edge of the granites. The same rocks are found up the English River as far as Otter Lake, where the Laurentian gneisses come in about two miles south of the head of the lake. At the expansion of the river into which Jarvis or Night-owl River flows, the gneisses are within a mile or less of the shore, and at one point, two miles east of the mouth of the river, the schists show

English River.

arms and veins from the granite, cutting them in various directions, but generally along the planes of schistosity. Again, at Flying-loon Lake, another expansion of the river, the main Laurentian area is entered, its northern edge lying two miles from the south-west end of the lake. The rocks in immediate contact with the granite here are coarse, massive diabases. These rocks occupy the whole northern side of the lake, with the exception of a few hundred yards, about midway, where the red, biotite-granite of the south shore cuts into them and forms the immediate shore-line. A small, isolated area of rather coarse red, biotite-granite of even grain, occurs at the fall which forms the outlet of Flying-loon Lake. Southwards along the route from Otter Lake towards Ignace station, obscurely foliated, granitoid gneisses are continuously exposed, striking, wherever the foliation is clear, about east-and-west. In the vicinity of Ignace, and over a large area to the north and north-west of it, the rocks are non-foliated, and the granite consequently furnishes a good building stone, which is being largely used by the Canadian Pacific Railway for the construction of bridge piers and foundations.

Otter Lake to Ignace.

"The English River, at the time of our survey, early in July, was found to be almost at freshet height, so that its ascent was much slower than it would have been at ordinary summer level. A fall, with three short rapids immediately above it, occurs at the mouth of the river, and necessitates a portage of a little over three-quarters of a mile, or, at low water, four short portages. The total rise is here about forty-five feet. The next rapid, past which there is a portage twenty-eight chains long, and which rises about six feet, is only a mile above the first. A quarter of a mile further up-stream, rapids with an ascent of twenty feet, are passed by a portage of sixty-five chains. A mile and a-half of canoe navigation intervenes between this and the next rapids, where there is a rise of about ten feet and a portage of twenty-eight chains. A lake-like expansion of the river here extends westward for two miles and a-half, receiving near its head the waters of Beaver River which drains a lake of considerable size lying to the north-east of Basket Lake and known as Beaver Lake.

Route by English River.

"Swift water with numerous rapids following closely upon one another continues to Flying-loon Lake. In this distance of eight miles there are five short portages with a total rise of about forty-five feet. A rise of about five feet, with a short portage and a stretch of one mile of very rapid water, separates this lake from Jarvis Lake, between which and Otter Lake there is a rise of perhaps six feet. At Otter Lake the river divides into two branches, one draining a short chain of lakes lying to the north-east and forming the route of travel

Two branches of river.

to Sturgeon Lake and all eastern points, and the other, the main English River, coming in from the south. The main river was followed to Bear Lake which is about thirty feet higher than Otter Lake, the principal rise occurring at three short rapids near Bear Lake. The total ascent between Minnitaki Lake and Bear Lake is, therefore, in the neighbourhood of one hundred and sixty feet.

Alternative route from Ignace to Minnitaki.

"Another route from Ignace to Minnitaki Lake, lying south of that above described, was then surveyed. The first lake of any considerable size on this route is that roughly indicated on some maps and called Orang-outang, evidently a mistranslation of the Indian name Mameigwess, meaning a 'wild man' or 'dweller in rocks.' This lake is reached from Sand Point Lake by ascending a smooth-flowing, winding stream of ample volume for loaded canoes. The exposures of rock along the river are of biotite-granite and very obscurely foliated granitoid gneiss. Mameigwess Lake has a coast-line of about thirty-two miles and lies wholly within the gneiss area. Kukukus (Night-owl) Lake, is reached from Mameigwess by a series of five smaller lakes, gneisses only occurring all along the route as well as about the shores of the lake itself. A micrometer survey of the lake gives it a shoreline of fifty-five miles and a total length of a little over thirteen miles. It discharges into English River at Flying-loon Lake by a short river with numerous rapids and a descent of thirty-five feet. Basket Lake and a crooked, narrow lake thirteen and a-half miles long lying just east of it, were also surveyed, together with the river by which they discharge into Kukukus Lake. A few small areas of pine still remain on the shores of the river and lake. The rock exposures show no variation from the granitoid biotite-gneisses, excepting in the replacement of the biotite constituent by hornblende, which occurs in a few places. The very irregular shape of the lake gives it a shore-line disproportionate to its area, the former measuring fifty-six miles and the latter only a little over fifteen square miles.

Beaver Lake.

"Minnitaki Lake was reached by way of Beaver Lake, eight miles long, and several small lakes. The granitoid gneisses continue to within a mile of the east end of Kapikwabikok, the strike of the foliation swinging from north-east on Beaver Lake, to nearly north, parallel to the edge of the area as its western limit is approached.

Route from Little Wabigoon to Ignace.

"A route from Little Wabigoon by the Wabigoon River to the head of Turtle River was then examined, and thence, by a series of lakes and streams the head-water of Turtle River was connected by a micrometer survey with the Canadian Pacific Railway at Ignace Station.

"The route followed, up Snake River through Long Lake and another narrow lake to its head-waters, continued in rocks of Keewatin age from Wabigoni to beyond Bending Lake on Turtle River. The north-eastern edge of this Keewatin belt was fixed at a number of places along the route by offsets through chains of smaller lakes, and proved to be close at hand all along—never at a greater distance than three miles from the main route. This gives to the belt a width varying from twelve miles, at Snake Lake, to eight at Bending Lake. It was found to terminate just beyond Bending Lake, becoming gradually more and more metamorphosed, the diorites and green schists towards the end becoming hornblende-schists and fine hornblendic and micaceous gneisses, having a strong resemblance to the Coutchiching of Rainy Lake and cut in all directions by veins and masses of coarse, white, pegmatite-like, granitoid gneiss. On the western side of Bending Lake, the hornblende-schists are interlaminated with seams of magnetic iron, sometimes as much as a few inches in thickness. These occur in sufficient volume to render compass work about that part of the lake quite impracticable, but they were not seen, in the hurried examination we were able to make, in such quantities as to be of any definite economic importance. On Birch Narrows or Richard Lake on which the extension of this band south-easterly would be exposed, no trace of Keewatin rocks is seen, unless they are represented by the bands of fine black hornblende-gneiss that occur there, in insignificant volume as compared with the coarse, white, biotite-granite and granitoid gneiss and which are contorted and cut by the latter rocks.

Extent of Keewatin.

Iron ore.

"On the route north-eastwards to Ignace, a belt of Keewatin rocks consisting for the most part of highly crystalline hornblende-schists and fine gneisses, is crossed just south of Ogema Lake. It has here a width of from two to three miles only, and represents in all probability an extension of the belt which crosses the railway between Taché and Raleigh. South of the belt, the gneisses have a general east-and-west trend, and north of it a north-easterly foliation.

Keewatin at Ogema Lake.

"In this belt, on an island in the lake south of Ogema Lake, occurs a quartz vein varying in width from over six feet to quite narrow, which has been partially stripped. In places it is well mineralized with pyrrhotite and pyrite with some calcopyrite and is, as far as can be seen from present stripping, very irregular, with spurs running along the foliation of the inclosing hornblende-schists and mica-schists. It is stated that assays have given a certain amount of gold.

Quartz vein.

"For the purpose particularly of fixing the limits of the Keewatin belt crossing the railway east of Taché, surveys were made of lakes lying to the south of the track between Raleigh and Butler stations.

Keewatin belt at Taché.

These lakes were reached by way of Mameigwess, by a route that crosses the railway near the 265th mile-post and follows the Wabigoon River up its principal branch, to a large lake having an elevation of about a hundred feet above the railway, not more than two miles from the track. The whole ascent is practically made in a distance of seven chains, where the river forms a succession of vertical pitches. About the lake hornblende-schists and diorites are well exposed, everywhere much crushed, twisted and invaded by granites, which on both the east and west shores of the lake occur in massive form. A series of small lakes, most of them merely beaver ponds, was followed southerly for about four miles from the south-east bay of the lake, and a very much mixed set of diorites, hornblende-schists, quartz-porphyries and fine gneisses was found to extend for the whole distance. Frequently no sharp line of demarcation could be drawn between the schists, gradually merging into fine gneisses, and the ordinary gneisses of the Laurentian area, a species of contact which seems to characterize the relations of the Laurentian to this Keewatin band all along.

Wabigoon River.

" A track-survey was made of the Wabigoon River, and the western edge of the granite area of Blueberry Lake was better defined. It is along this contact and in a belt of Keewatin adjoining it, that so many promising properties have been taken up during the past year. To assist the development of these, a road has been cut out from the Canadian Pacific Railway into the centre of the mining district, locally known as the New Klondike.

Auriferous quartz veins.

"Work, at the time of my visit, was being done on two properties, numbered 416 HN. and 419 HN. respectively. On the first, held by a Winnipeg company, a shaft of eighty-feet has been sunk, but was full of water, and preparations for pumping it out were then in hand. The main vein at the outcrop varies in width from eighteen inches to less than a foot. It was found to hold a course of N. 64 E. (mag.) for about three hundred feet, where a sudden bend easterly, almost at right angles, was accompanied by the development of a mass of quartz forty or fifty feet in diameter, with the outer wall underlying at a very appreciable angle towards the original vein. At a distance of sixty feet the vein resumes its original direction and size and has been stripped for a further distance of five hundred feet. Beyond this, Mr. Thos. Hogan, who is engaged in its development, states that he has traced it across the two succeeding locations. The vein occurs in a quartzite-like rock which merges into a quartz-porphyry, which is itself probably intrusive in the crushed diorites that form the prevailing country-rock. The vein is generally well-defined, with good walls, and carries zinc-blende in notable quantity with iron-

pyrites and chalcopyrite, and shows some free gold. A spur offsetting to the south-east forms a narrow vein which is also fairly well mineralized. A good, general average gold-content, is claimed for the main vein.

"At 419 HN., sinking was being pushed forward in a shaft that had then reached a depth of 115 feet. The vein, which was being developed by an English company, was small, running from a foot to only a few inches, and had been traced on the surface for only a short distance. The values were high enough, however, to warrant its development, in the hope that it might strengthen in depth. After losing the vein at eighty feet, the shaft was continued downwards and the vein, or a vein, was again picked up, which, at 115 feet showed six inches to ten inches of quartz across the shaft. Like 419 HN., the quartz carries iron- and copper-pyrites and zinc-blende, with a considerable amount of visible free gold. The containing country-rock is here a green schist, evidently derived by shearing from a diorite or diabase,

"Work, in the way of stripping, test pits, etc., has been done on a number of properties in the neighbourhood, that lie in a contact zone of the Keewatin with an intrusive granite area. Spurs of the granite invade the green schists in many places, and it is not improbable that some at least of the quartz-porphyries are phases of the granitic intrusive, although generally they seem to represent the later extravasations from the magma which supplied the basic diorites at an earlier stage.

Rocks seen along railway.

"The remainder of the season was spent in making an examination of the section afforded by the exposures and cuttings along the line of the Canadian Pacific Railway, which traverses the area of the sheet from north-west to south-east. The western end of the section shows the lacustrine, stratified, silty clays extending easterly along the track to between Dyment and Taché stations, or to an elevation of a little over 1250 feet. Occasional exposures of Keewatin schists are to be seen outcropping here and there through the drift to within about half a mile of Taché, where the north-easterly corner of the granite area of Blueberry Lake crosses the track and extends along it for about two miles. Beyond, and extending eastward for six miles, or to just beyond Raleigh, is another belt of Keewatin, made up for the most part of hornblende-schist and very fine gneiss.

Stratified silts.

Gold locations near Raleigh.

"Near the contact of these rocks and the granite, a number of locations have been taken up, and on one at least some preliminary work has been done in stripping and sinking a few test-pits. The country-rock here is a hornblende-granite that incloses blocks and

extended, broken bands of diorite. It shows often an obscure foliation striking about N. 55° W. The quartz occurs as a series of lenses of very irregular shapes and sizes, along a line running about N. 20° E., and probably representing a line of fracture. The mode of occurrence of the quartz is extremely irregular. It varies from stringers and small lenses one foot in diameter, to masses fifteen to thirty feet across, often with their longer diameters parallel to the foliation of the rock and nearly at right angles to the line of outcrop of the quartz. Following the line of outcrop, the quartz can be traced, not continuously, but in exposures occurring at close intervals, for a distance of about fifteen chains.

"The quartz is not highly mineralized, showing, as far as noted, only a little iron-pyrites. Samples taken from the surface and representing as nearly as possible the average quartz are being analyzed in the laboratory of the Survey.

Granitoid gneiss.

"After crossing the Keewatin belt above mentioned, the remainder of the section to English River lies entirely in the granitoid gneisses striking generally but a few degrees either way from east-and-west.

Silts.

The white, silty clay of the Wabigoon area does not again appear. Cuttings through drift are, however, numerous, showing with but a few exceptions unstratified material, varying from a clay inclosing large angular boulders through coarse gravel to sand. All seem to be glacial in origin and they are seldom even modified by subsequent water action. Glacial striæ, averaging about S. 30° W. in direction, are seen at many points."

Work by Mr. D.B. Dowling.

Mr. Dowling was employed during the early part of the year in compiling certain facts relative to the orography of the Arctic Islands and the northern part of the continent for mapping purposes. He also completed a draft report on the Cambro-Silurian rocks of the Lake Winnipeg Basin, which had been delayed pending the examination of the fossils collected there, undertaken by Mr. Whiteaves. He also prepared the manuscript of the Lake Winnipeg map-sheet for the engraver.

Lake Nipigon.

As it appeared desirable that the geological examination and survey of Lake Nipigon, already partially accomplished by Dr. Bell in 1869 and 1871, supplemented in 1894 by a traverse of the shores by Messrs. McInnes and Dowling, should be completed for publication, Mr. Dowling was requested to undertake this work. The survey made in 1894 consisted of a traverse with transit and micrometer around the shore-line, while many large islands and two large bays had not been visited. Arrangements were made with the Hudson's Bay Com-

pany whereby the use of one of their large sailing-boats was secured, and a cedar canoe was shipped to Nipigon Station by rail. On the work Mr. Dowling reports as follows :—

"Leaving Ottawa on the 16th of July, I proceeded to Nipigon station, near the outlet of the Nipigon River, where four men were hired. Two of these, Indians from Lake Nipigon, had brought a boat over from the Company's trading post for our use. This had been left near the outlet, and the men coming down by canoe arrived before the party had been completed. With a good load of provisions in the canoes we reached the lake on the 24th of July, and the survey of the islands was commenced the next morning. The order in which they were visited was in a general way from south to north-west and then north and eastward till all were surveyed, or, in the case of small ones, fixed by cross bearings. Several elevated points on the mainland and islands afforded good views, and were occupied as transit stations, from which a series of angles on the positions of islands were read and sketches made. Thus at Gros Cap on St. Paul Island, our station was at an elevation of 300 feet, and we had a view to near the north end of the lake. Our station on the south-east end of Grand Island was at an elevation of over 200 feet, while that on the Outer Barn was at 450 feet, affording a view in which the whole width of the lake was seen and angles read on elevated points up to forty miles away. Other stations at lesser elevations furnished a network of triangles covering the width of the lake, so that a connection across was made at several points. Ombabika Bay, across the mouth of which we passed in 1894, was traversed by transit and micrometer during this season, as also Pijikawabikong Bay at the south-east corner of the lake. Several streams entering the lake, mainly on the east side, were ascended, and estimated traverses of their courses were made. From Ombabika Bay, Little Jack-fish River was traversed for fifteen miles. The Vermilion River, emptying into Humbolt Bay, was examined for a similar distance, and the Sturgeon River, near Poplar Point, was ascended to a point about twenty miles from the lake. Two routes being known to our men, we left the river at the first long portage, and by a chain of lakes to the south, followed parallel to the river for nearly ten miles, then, returning to it again we ascended as before. On the return journey the whole of the river so avoided was traversed.

Triangulation surveys of islands.

Surveys of streams.

"Smaller streams were found flowing from the east, but as they are little travelled by the Indians short excursions only were made up these.

"The survey of Nipigon River made in 1894, did not include the upper part, or that above Lake Hannah, the short route to the lake *via* the Flat-rock Portage having been followed. This gap was therefore filled by our surveys made at the close of this season. A map of the lake and river can now be compiled. The need of a good geographical chart of the river may be inferred from the fact that over four hundred and fifty sportsmen visited this river during the fishing season from June to the middle of September.

Rocks of the islands.

"The rocks of the islands in the central portion of the lake are all formed of trap—the 'crowning overflow' of the Nipigon formation, while a few at the north extreme and near the eastern shore, as in Ombabika Bay and Humboldt Bay, are of gneiss and dark-green schists referable to the Archæan. Little arable land is to be found on any of them, as the covering of drift is very thin and consists mainly of boulders, while the surface of such as are formed of trap is very irregular being generally a mass of broken fragments.

Shakespeare Island.

"Several of the islands are of considerable extent. Shakespeare Island, east of the entrance to McIntyre Bay, is roughly rectangular in outline, six miles long from north to south,, and five miles broad, but from the eastern side, a group of islands appears to extend this, five miles in a south-east direction. Several high hills form prominent landmarks, the most conspicuous being Paupuskeese Mountain, an isolated mass of trap near the west end of the island. A high ridge at the north-east corner is also prominent, as well as Hat Mountain on one of the islands of the group to the east.

Grand Island.

"Grand Island, near the western shore, is roughly triangular in shape with a length of about ten miles. The coast-line measures over twenty-seven miles. The main body of the island is high, having a general elevation of over two hundred feet above the lake.

"Stretching northward, and separated by narrow channels, are several large islands reaching to near the north end of the lake. These, with the addition of Murchison Island, a large high island near the east shore, constitute the main body of the islands of the northern part, though numerous others of smaller size are scattered about in an irregular manner. The whole group occupies an elliptical area inclosing a rather shallow basin in the centre of the lake. Between these islands and the eastern shore, a very deep channel is found, evidently formed by the denudation of the trap and underlying sediments down to the original floor, and as the Archæan rocks are found along the eastern margin of the lake overlaid by heavy beds of trap, the slope of the original basin must here have been very steep.

"Livingstone Point, on which a heavy bed of trap still rests, shows the upper surface to dip very sharply to the west. The inner end of the trap hill reaches to a height of about six hundred feet, while the western end is only about two hundred feet in elevation. The inner side of the ridge inclosing Ombabika Bay is also much higher than that facing the lake. The inland extensions of these ridges about the northern part of the lake are eroded away, and the Archæan rocks succeed them to the east, but toward the south-east the limit of the trap is apparently at a greater distance from the lake, and could not be ascertained without many traverses across country eastward.

Eastern edge of trap.

"The topography is without doubt greatly influenced by the erosion of the great mass of trap that may be said to have filled the basin. The exposures all along the lake, show the mass to have been very much broken by vertical fissures, so that most of the cliffs are subject to frequent falls of rock; but a series of greater fissures would appear to have also been formed upon the cooling of the mass of molten trap. These no doubt surrounded, in an irregular manner, local centres of greater thickness, and were enlarged by the subsequent sinking of parts of the basin owing to the displacement of such a large mass of erupted material from below. That these great lines of fissure extended along the eastern side of the basin, is shown by the existing traces in the mass of trap confining the southern end of the lake, the outlet by the river being roughly along a great fault or break forming a cañon, the eastern side of which is almost precipitous, and rises to nearly six hundred feet—the western side very much lower and decreasing in height to the northward. Other great faults no doubt run northward between the islands and the ridges on the east shore.

Faults.

"The denudation of the rocks along minor lines of fracture is well exhibited in Pijitawabikon Bay, a long, narrow break in the high plateau, branching out at its head into irregular, small, deep gullies, in which are insignificant streams.

"Many of the high ridges appear to be of the nature of immense dykes, and it is found that at several points the trap has broken up through the limestones and underlying sediments, displacing and disturbing them laterally, as at Cook Point, or filling gaps or breaks in the Archæan, as was noted near the mouth of Little Black River, and at the long portage on Sturgeon River.

Great dykes.

"It was found, by ascending several streams from the north and east shores, that a terrace of sand, about one hundred feet above the lake, through which the streams have cut deep valleys is here developed. The upward extension of the terrace, limited in width by the slope of

Sand terraces.

the underlying rocks, was found on the Jackfish River to be nearly ten miles, and on Vermilion River and other rivers farther south along the east shore, was considerably less. The White-sand River, on the west side of the lake, also flows through sand terraces, and a lower one is found spread out over the low country from this river to Mount St. John.

" Vermilion River and Sturgeon River, on the eastern shore, also show deposits of stratified sand, from an elevation of nearly one hundred feet down to near the lake-level.

" The underlying rocks are seen on these streams only at the various rapids and falls. On Little Jackfish River, greenish gneisses and schists, similar to those of the Couchiching series, are met with, and on the Vermilion River, which enters Humboldt Bay, schists and greenstones of the Huronian, form a band running east-north-east from the head of the bay. At the first rapid and on the island at the mouth of the stream, the contact between these dark rocks and the gneisses is found. It is of the nature of a zone of intrusive granite in which contorted stringers of both rocks are found, the general strike of both gneiss and schist being nearly parallel, running about ten degrees north of east.

Huronian rocks.

" The Sturgeon River, for twenty miles, or as far as traversed from the lake, occupies a depression in rocks of the Huronian, running very closely along the strike, so that no great width of beds is seen; but besides the greenstones and schists so common to this formation, beds of coarse conglomerate occur on the lake route above the long portage. A high ridge of trap starting from Mungo Park Point on the lake, north of the mouth of the river, runs in a direct line south of east and crosses the valley of the river at the long portage.

" An abrupt break of half a mile in width, allows the passage of the stream, and through this the river pours over many small falls and rapids, past which a portage of a mile is made, the fall in that distance being over fifty feet. The rocks above and below being of Huronian greenstones, this ridge appears to be of the nature of a great dyke, as all the exposures on the stream in the gap are of the dark brown trap. A number of mining claims were staked out at the mouth of the river some years ago, but no paying ores appear to have been found. Ore from a band containing disseminated pyrites was shipped out, but appears to have been of little value. The stream has been prospected but without very much success. Specimens of the ores from the mouth of the river, as well as a pyritous rock from the Steep-rock Fall near Crooked Lake, were secured. Gold was reported as discovered west of Nipigon River in the vicinity of the western part of Purdom

Economic minerals.

township. The sample that was shown me consisted of a small piece of quartz in which several particles of gold were plainly visible. As the locality was not yet staked out it was kept secret.

"During the course of the work, twenty-five photographs of lake features and rock structure were taken and a series of rock specimens was collected.

"Our surveying operations terminated on Sept. 21st at Camp Victoria, and we then procceded to Nipigon, where the men were paid off and the canoe and camp furniture were stored. Ottawa was reached on Sept. 26th."

Dr. R. Bell devoted time during the winter of 1897-98 to writing a report for issue with the French River sheet of the Ontario series of maps; also to geological and topographical compilation connected with other maps on the north shore of Lake Huron. The discovery of gold at Michipicoten having drawn a good deal of attention to that district, Dr. Bell was requested to undertake a further geological examination of it, his preliminary report upon which is as follows:—

Work by Dr. R. Bell.

"The field-work of the season of 1898 occupied about four months. I left Ottawa on the 5th of July and returned on the 8th of November. The greater part of this time was spent in the Michipicoten gold district, which lies at the north-eastern angle of Lake Superior, but having completed the principal field-work there early in October, the remainder of that month was devoted to making a survey of the whole course of the White River or eastern branch of the Missisagui (or Missisauga) and an exploration of the country about its source, in order to complete for publication the northern part of map-sheet 129. I have to thank Messrs Eddy and Jordon for facilitating this work.

Michipicoten district.

"In performing the work in the Michipicoten district, my party consisted of two assistants, Mr J. M. Bell and Mr Howells Frechette, and from five to seven bush- and canoe-men as required; but while engaged in the White River work during the remainder of the season, I was accompanied by only two canoe-men. I may here express my entire satisfaction with the efficient manner in which every member of my party performed his duty.

Party.

"It was the discovery of gold near Michipicoten in 1897 that rendered it desirable to have a more exact and complete survey of the surrounding district than had hitherto been made. The most important section of the gold-bearing area of this region lies within the western half of map-sheet 143, of the Ontario series, the remainder of the

Position of gold discoveries.

auriferous tract extending northward into the ground covered by sheet 156, of which both the topography and geology are sufficiently well shown on my map of the basin of Moose River published in 1881.

Michipicoten mining division.

"Following the discovery of gold at Wawa Lake, near Michipicoten, a large tract around the north-east angle of Lake Superior was proclaimed as a gold district by the government of the province of Ontario in 1897. This district is described in 'an Order in Council approved by His Honour the Lieutenant-Governor the ninth day of September A. D. 1897', as the 'tract limited upon the east side by the meridian of the east end of Dog Lake or say eighty-four degrees west from Greenwich, on the south side by the latitude of Cape Gargantua, say forty-seven degrees thirty-six minutes, on the north side by the latitude of forty-eight degrees thirty minutes, and between the westerly ends of these lines of latitude where they touch Lake Superior, by the shore-line of said lake, containing about five thousand square miles, be declared a Mining Division and that the name thereof be the Michipicoten Mining Division.'

Previous work.

"I had incidentally done more or less topographical and geological work in this region in the years 1875, '76, '77 and '81, which, with the results of the present season's operations will enable me now to compile a map of it showing both the geography and the geology with considerable accuracy of detail.

Difficulties encountered.

"The district is not an easy one to survey and map, because of its primitive condition and other circumstances. There are only a few canoe-routes within its limits, and these are difficult on account of the numerous portages, as well as the broken and rapid character of the streams, due to the general slope of the whole country towards Lake Superior. No roads or surveyed lines exist, while the hilly nature of the district and the almost impracticable character of much of the bush, render 'traversing' in the woods a very arduous undertaking. In spite of these obstacles, however, I succeeded in obtaining all the data required for the construction of a map. Within these limits we made micrometer surveys of the coast of Lake Superior to the western and southern margins of the sheet, and also of all the streams and inland lakes where canoes could be employed. Sketch-surveys were made of the smaller streams and of the lakes inaccessible to canoes, while various trails and all the old tote-roads which had been used in the construction of the Canadian Pacific Railway, were carefully located on the map by pacing and taking compass bearings of every change in their course. Finally, in order to ascertain the geology in sections where no prominent topographical features were known to exist, we made numerous traverses through the bush, some

Surveys made.

of them being of considerable length. Our difficulties were increased by continued wet weather, the season having been the most rainy one for the last thirty years. The insect pests, which are always a serious obstacle to all kinds of work in the woods during the summer season, were this year unusually troublesome, especially the mosquitoes, black flies and sandflies.

Insect pests.

"As many observations for latitude were obtained as the weather permitted me to take. A considerable number of photographs were secured, and barometric readings were everywhere recorded in order to ascertain the elevations of mountains, hills and terraces, as well as of lakes, waterfalls and river-stretches. The temperature of the water was noted every day as an indication of climate. Notes were constantly made as to glaciation and surface geology, which are always interesting and often important subjects. Particular attention was paid to the nature and the mode of occurrence of the gold-bearing veins of the district. The principal discoveries were visited and fair samples for assay were broken by myself from the veinstones *in situ*. Observations were always noted as to the distribution and the local characters of the forest trees. But as I had made large collections of plants in this district in previous years and had also made somewhat extensive collections of insects of the orders Coleoptera and Lepidoptera, I did nothing further in these lines during the past season.

Observations and photographs.

Specimens collected.

"It would have facilitated my geological work very much if accurate surveys had previously been made of the principal topographical features of the district, because the time I was obliged to devote to this work necessarily occupied a large proportion of the season.

Want of topographical surveys.

"A considerable proportion of this district is occupied by two belts of Huronian rocks, lying at right angles to one another; the larger one, which for convenience we may designate the Michipicoten belt, running north-eastward, and the smaller, which may be called the Cap Choyé belt, south-eastward from Michipicoten Bay. A narrow interval of granite at Burnt Point, separates these at the shore of Lake Superior; but inland, the extension of this granite occupies the whole of the triangular space between the two belts and the eastern boundary of the sheet. The larger belt is bounded on its north-western or outer side by the older Laurentian gneisses, and the smaller one on its south-western side by both granites and gneisses.

Huronian belts.

"The former has an average breadth of about fifteen miles, and it extends from Michipicoten Bay to a short distance beyond the line of the Canadian Pacific Railway at Missinabie station, a distance of forty-six miles. On the shore of Lake Superior it reaches westward

Michipicoten belt.

from the mouth of Michipicoten River to Dog River, a distance of ten miles, and southward from the former river to Burnt Point Harbour, a distance of ten miles also. Near the mouth of Michipicoten it throws off two narrow spurs to the eastward, each of which runs into the granite area a distance of about ten miles. Without a map to accompany the description it is difficult to convey an accurate conception of the form of this belt or triangle. It may, however, be said that its north-westerly boundary runs as a curving line north-easterly from the vicinity of the mouth of Dog River on Lake Superior to the Magpie River, which it intersects at about eleven miles in a straight line below the crossing of the Canadian Pacific Railway. The south-easterly boundary, after giving off the two spurs already mentioned, follows a north-easterly course to the outlet of Mattagaming Lake (often erroneously called Dog Lake).

Rocks of this belt.

"The rocks of the Michipicoten belt consist mainly of slaty and amorphous greenstones with occasional massive crystalline varieties. There are also smaller proportions of hornblende-schists and mica-schists, greywackes, argillites and clay-slates, siliceous, felsitic and other crystalline schists, quartz-porphyries, conglomerates or agglomerates, breccias, dolomites, etc., in still smaller amounts. An isolated area of red granite about two miles in length occurs on the west side of the Magpie River just above the second portage from its mouth.

Outlines of Michipicoten belt.

"The following is a more detailed description of the Michipicoten belt:—Beginning at its southern extremity, the line of contact between the granite on the east and the Huronian schists and other rocks on the west, runs northward from Burnt Point Harbour with an eastward curve to the Michipicoten River, which it strikes about two miles from the mouth. The boundary next runs south-eastward along the southern side of the spur of Huronian rocks above mentioned. The north-eastern side of this spur, which runs south-east, crosses the Michipicoten River just above the foot of Long Portage. From this point upward along the river, the rocks, as far as the junction of the Sequamka, are mostly gray granites of various shades and textures, while those south of the mouth of the river are mostly red granites.

First spur.

Second spur.

"The second of the narrow Huronian spurs already mentioned, crosses the Michipicoten River at the mouth of the Sequamka River. This stream was surveyed by micrometer to the edge of the sheet, and the rocks observed upon it consisted entirely of gneiss, the strike of which varied from W.N.W. to W.S.W. Gneiss occurs again at Cat portage on the Michipicoten about a mile above the Sequamka, and

also in the hills to the north-west of the outlet of Whitefish Lake, striking east-and-west in both localities.

"Around the shores of Whitefish Lake, at Pigeon portage and about the southern part of Manitouwick Lake, the rocks are mostly gray granite. On other parts of the latter lake, gneiss, greenstone and green schists as well as granites are found. Near the south-western extremity of the main body of this lake, a hill of gray granite on the north-west side is faced by a large dyke of diorite, which forms a bluff 250 feet high. The dyke may be 300 or 400 feet in width, and it runs about south-west and north-east. Its existence may have had some connection with the geological history of the lake, which also runs in the same direction. The diorite is lighter in colour and coarser in texture in the centre of the dyke than towards the sides. Rocks on Whitefish Lake.

"The canoe-route from Manitouwick to Wawa (properly Wawagonk), which I also surveyed by the micrometer, follows a chain of small lakes and streams, lying in a tolerably direct course. Several excursions were also made from the line of this route into the country on either side, for the purpose of ascertaining the character and extent of the rock-formations. With the exception of a hill of gray gneiss 300 feet high on the north-west side of the route, the only rocks seen between Manitouwick and Hawk lakes consisted of red and gray granites, which continue to the second pond south-west of the latter. From this pond to Wawa Lake, there is a variety of green and grayish crystalline schists and greenstones, agglomerates, greywackes, etc. Manitouwick to Wawa.

"Around Wawa Lake and thence to the mouth of the Michipicoten, slaty and massive diorites prevail. In the hills overlooking the northern side of Wawa Lake near its north-eastern extremity, a massive looking white-weathering rock is very conspicuous owing to the woods having been mostly burnt off. It consists of a compact light-reddish felsite with a decided conchoidal fracture and showing lines of lamination parallel to the general strike of the other rocks in the neighbourhood. The white crust, due to weathering, which generally characterizes felsites is here very marked. Wawa Lake.

"The tote-road from the north-east end of Wawa Lake to Grasett station on the Canadian Pacific Railway, which was in use during the construction of the line, was surveyed by pacing and bearings all the way to the northern edge of our map. It crosses the Magpie River about eight miles within the sheet. The rocks observed along this road are all Huronian and consist of massive and schistose greenstones, a variety of schists some containing much free silica, gray micaceous schists, solid and schistose graywackes passing into gneiss and felsitic schists of various colours. Wawa to Grasett.

Magpie River. "On the Magpie River, between its mouth and the northern margin of the sheet, the rocks noted were massive diorites, both crystalline and micro-crystalline, slaty diorite, chloritic, micaceous and hornblendic schists, soft, light-greenish-gray schists with calcspar, sericite, glistening gray schist, volcanic breccia and graywacke schist-conglomerate, besides the small area of red granite already mentioned.

Cap Choyé belt. "A cross-section of the smaller or Cap Choyé belt, at right angles to its strike, occupies the coast of Lake Superior from Old Woman River to the bay on the south side of Cap Choyé. This belt runs inland in an east-southeasterly direction and has an average width, as ascertained by different traverses, of eight or nine miles, or about two-thirds that of the Michipicoten belt. Its boundaries appear to be nearly parallel to one another. The rocks of this belt consist principally of schistose greenstones, siliceous and coarse argillaceous schists, together with smaller proportions of other crystalline schists similar to those which have been mentioned as occurring in the Michipicoten belt. A patch of red granite within this belt was observed on the shore of Lake Superior. The existence of these Huronian rocks in this section of the coast is shown on my map of 1881, already referred to, but it was only during last summer that we proved them to form a great belt running across the sheet. This fact is an important addition to our knowledge of the geology of this district, as these rocks will probably prove auriferous like those of the Michipicoten belt. A good many years ago, a quartz vein, said to be large and well charged with copper-pyrites was found and opened by a Mr. T. Fréchette, about fourteen miles east of Gargantua Harbour. We were unable to rediscover this vein, but we came upon the prospecting camp in its vicinity and obtained some samples of the ore which are rich in copper and may contain gold as well. I was credibly informed that another copper vein had been discovered in the course of this belt further east, or at a place lying to the northward of the mouth of Agawa River.

Economic minerals. "The economic minerals of the Michipicoten mining district hitherto discovered, consist of iron, copper, and gold ores, and granite suitable for monuments and construction.

Iron. "*Iron.*—A large deposit of iron ore occurs on the shore of Lake Superior at Little Gros Cap, near the mouth of Michipicoten River, and an attempt was made to mine and export it about twenty-five years ago. As the locality is fully described in my report for 1876, nothing further need be said in regard to it.

Copper. "*Copper.*—Thirty years ago, indications of copper were discovered at several places around Wawa Lake, and a Mr. J. T. Johnson of Detroit purchased from the Government a number of large locations

surrounding the north-eastern half of the lake. Some prospecting was done on one of these, near the centre of the south side of the lake, and, I was informed by a man who had been engaged in the work, that a promising vein of quartz with copper-pyrites had been found. Some of the ore may still be seen lying about at the site of the buildings which were erected at the time the prospecting was going on, but as the location is now overgrown by a dense thicket of brush-wood and young trees, we were unable to find the old workings. The occurrence of copper-pyrites at two localities in the Gargantua Huronian belt has been referred to in describing these rocks.

Gold.

"*Gold.*—In the Michipicoten district, the precious metal occurs in the form of finely disseminated free gold in quartz veins. The principal discoveries so far have been made around Wawa Lake and all the way across the Huronian belt between this sheet of water and the foot of the Long Portage on Michipicoten River. The associated rocks are the schistose greenstones and greywackes with crystalline diorite or diabase occasionally in the vicinity. The veins in this tract are numerous and often of a good workable size—say from four to six feet in width. Their prevailing course approximates to a northerly direction. The quartz is of a hyaline variety and contains only very small quantities of associated minerals, comprising copper-pyrites and iron-pyrites with a little calcareous spar.

Prospecting work.

"So far, the work done can only be called prospecting. Numerous prospecting pits have been opened and at the Jubilee mine a shaft had been sunk to a depth of sixty feet on the underlie of the vein. As yet nothing can be said with certainty as to the richness of the ore, as no commercial tests have been made and the reported assays cannot always be relied upon. In some cases specks of gold in the quartz can be seen by the naked eye or with the aid of a magnifier. Average samples were collected by me for assay from the principal 'prospects.'

"On the south side of Michipicoten River and thence to Burnt Point, several quartz veins have been discovered and mining claims located, but I was only able to visit one of these.

Alluvial claims.

"The sands and gravels of the valleys of the Michipicoten and Magpie rivers, having been derived largely from the disintegration and glacial crushing of the Huronian rocks of the vicinity, in which no doubt great numbers of small as well as some large quartz veins existed, contain a notable proportion of quartz vein-matter. It is said that the more quartzose of these gravels and sands have yielded gold on assay, and, in consequence of such reports, many sand claims were started and registered in the books of the local inspector of mines, but I have no reliable data as to the proportion of gold which

may have been detected. No attempt has been made to work any of these claims."

Work by Mr. A. E. Barlow.

The greater part of the winter of 1897-98 was spent by Mr. A. E. Barlow in working up the various surveys made during the preceding season in connection with the Haliburton map-sheet, (No.118) while progress was made in the collection and compilation of material necessary for this map. A part of his time was likewise devoted to a study of the geological results obtained during the progress of the field-work, as well as to the examination of the large number of rock-specimens obtained. The report in connection with the exploration and surveys of the area covered by the Nipissing and Temiscamingue sheets was completed and is now in the press.

The geological investigations carried on for several seasons past in Central Ontario by Dr. F. D. Adams and Mr. Barlow in collaboration, were continued during the past summer. These gentlemen were assisted, particularly in regard to the necessary measurements and topographical surveys, by Mr. J. Keele, Mr. G. W. Ross, jr., and Mr. F. G. Stevens.

Field-work by Messrs. Barlow and Adams.

The close association in which Messrs. Adams and Barlow have worked in the field, renders it appropriate that their progress report upon the work should be made jointly. In the following pages the observations of both gentlemen are therefore combined:—

"The work was pushed forward as rapidly as possible, but the geological boundaries are so intricate and the relations so critical and difficult, that part at least of another season will be required before a final report can be written. It was found necessary, in order that the structure of the district might be thoroughly worked out, to include in the area of survey a portion of the map-sheet to the south (No. 113) comprising parts of the townships of Burleigh, Methuen, Lake, Tudor and Grimsthorpe.

Topographical surveys.

"Re-surveys were made, by Mr. Barlow, of Loon Lake in Chandos township, Paudash Lake in Cardiff, Eel Lake on the boundary between Anstruther and Cardiff, and Bass Lake on the boundary between Limerick and Tudor. Mr. Keele made a survey of the Deer River from the outlet on Loon Lake, in Chandos, to Whetstone Lake, in the township of Lake, showing this crooked stream in detail, in a manner not attempted on the township plans.

"Besides this Mr. Keele made micrometer surveys of a group of lakes situated in the northern portion of Burleigh and the southern parts of Cavendish and Anstruther, including Long, Cox, Cold, Gold, Gull, Catchacoma, Bottle and Sucker lakes.

"Mr. Barlow's work, comprised the area composed chiefly of the granitic and dioritic gneisses, in the north-eastern part of the map from Egan Estate to Brudenell corner; while, in the southern part of the sheet, he worked chiefly in the district to the east of the Hastings road. Dr. Adams, with Whitney as a base, worked in the north-western part of the sheet, exploring and mapping geologically the townships to the west and south-west of Egan Estate station on the Ottawa Arnprior and Parry Sound Railway. Dr. Adams left Montreal for the field on June the 20th and returned on September 12th, while Mr. Barlow was engaged in field-work from June 25th to October 1st.

Area examined by Mr. Barlow.

"The great tract of country contained in the northern and north-western part of the map-sheet, exhibits a very typical development of the granites and gneisses of the Laurentian. The latter usually dip at low angles and are in some places quite flat, the strike running in great sweeping curves, often of considerable complexity. Three small outliers of the Grenville series were noticed on the shores of Barrys Bay of Lake Kaminiskeg, while two others occur between Hopeville and Emmett post-office in the south-western part of Hagarty township. In the vicinity of Rockingham and between this village and Brudenell corner, there is a large development of crystalline limestones belonging to the Grenville series and similar rocks may be encountered at frequent intervals between this place and Rochefort P.O., in the south-eastern corner of Hagarty. The Grenville series likewise occupies small patches in Monteagle and Carlow townships, but by far the greater part of these townships is underlain by the more massive granite and gneiss. A large irruptive mass, composed chiefly of granite, diorite and gabbro, covers the southern portions of Mayo and Dungannon and the northern parts of Cashel and Limerick, thence extending westward into the north-eastern corner of Wollaston. To the north, in the townships of Dungannon and Mayo, a large area of limestones and amphibolites occurs, cut through by a mass of intrusive material of both acid and basic facies. These rocks were formerly classified as belonging to the Hastings series, but certain portions present the highly metamorphosed character of the Grenville series. Similar rocks, some even in a less altered condition, are present to the south of these huge batholitic masses, covering the southern parts of the townships of Limerick and Cashel in the south-east corner of the sheet. At several places, notably in the vicinity of Gilmour station on the Central Ontario Railway and between this place and St. Ola station, detailed studies were made of the occurrence of certain 'conglomerates,' and the conclusions reached would seem to indicate that, in many instances at least, such rocks in these regions are not true conglomerates, but are

Fundamental gneisses.

Outliers of Grenville series.

Irruptive mass.

Examination of conglomerates.

of the nature of autoclastic rocks or dynamic breccias. These pseudo-conglomerates as here represented, would appear, in fact, to have been formed by the rending apart of certain of the more brittle bands, while the inclosing limestone or schistose matrix has yielded somewhat readily to deformation. The subject is of rather exceptional scientific interest and a paper by Mr. Barlow, covering the observations made, has lately been presented at the meeting of the Geological Society of America.*

Area examined by Dr. Adams.

"Dr. Adams, having completed his work on the north-west corner of the sheet on July 25th, left Whitney on that date and went south through the townships of Airy, Sabine, Nightingale, Bruton, Harcourt and Herschell to Baptiste Lake. Along this line an excellent opportunity was afforded for the study of the relations of the Fundamental gneiss to the great limestone-bearing formation known as the Grenville series, which appears in force on Baptiste Lake. On several lots on ranges IV. and V. of Bruton, a granular, white felspar rock was found, identical in appearance, and probably in composition, with the albite rock found associated with the nepheline-syenite in the township of Dungannon and elsewhere in the district about Bancroft, and which is there a differentiation product of the nepheline-syenite magma. No nepheline, however, could be detected in this Bruton rock. The first occurrences of limestone were found on the last range of the township of Harcourt. The occurrences of this rock, however, are small and disconnected, until the first ranges of this township are reached, when the limestones and the rocks of the Grenville series are seen almost continuously along the line of the Irondale, Bancroft and Ottawa Railway.

Felspar rock.

Limestone.

Intrusive contacts.

"The study of this region, showed conclusively that the contact between the Fundamental gneisses and the Grenville series is an intrusive one, and that the rocks of the last-mentioned series, have slowly sagged down into, or have been gradually uplifted by an underlying floor or batholite of granitic material. The chief developments of the Grenville series, run in great curves around these batholites, and in contact with granite material its rocks become broken into many discontinuous patches, usually manintaining the strike of the adjacent part of the formation from which they have been detached; showing that the rending action of the granite has been a slow and gradual one, and not of the nature of a violent intrusion.

Detailed work on Grenville series.

"The month of August and the early part of September were occupied in making a detailed study of one of the most complicated portions of

*Published in Ottawa Naturalist, vol. XII, No. 11, Feb., 1899, pp. 205-217, Plates VI-IX.

the whole district, comprising the township of Monmouth and portions of Dudley, Cardiff, Chandos, Burleigh and Methuen. In Monmouth there is one of the best developments of the Grenville series in the whole area, while, in the other townships, there are in addition excellent exposures of the Fundamental gneisses with great granite intrusions, as well as occurrences which have been referred to the Hastings series, the geology of the district being of the most intricate character.

"The study of the Grenville series in Monmouth, showed beyond a doubt, that this series is a sedimentary one. It includes a great development of bedded white quartzites, evidently altered sandstones. The associated limestones also, that occur in heavy bands, and, as everywhere else in the Grenville series are in the form of white crystalline marbles, were in a few plans along the line of the Irondale, Bancroft and Ottawa Railway, seen to hold little dark strings suggestive of remnants of the original limestone in a less altered condition. On this account, a careful search was made, which resulted in the discovery of two localites in which the limestone was almost unaltered, being very fine in grain and blue in colour, and bearing a strong resemblance to the limestones of more recent formations. In such cases the blue limestone is interstratified with the ordinary white coarse-grained marble of the Grenville series and passes into it, there being evidently portions of the limestones which have escaped metamorphism. These occurrences serve to dispose of any lingering doubts concerning the sedimentary origin of the limestone in question. The localities where these unaltered limestones are best seen are, lot 27 of range XIV. of Monmouth and lot 28 of range XI. of the same township.

Its results.

Unaltered limestones.

"The relations of the Grenville and Hastings series in this district were made the subject of careful study, and much additional evidence bearing on this disputed question was collected during the summer.

"Several new occurrences of nepheline-syenite were discovered during the past season, in the district examined. The most noteworthy is that which was found in the form of a wide band running through the township of Monmouth. It is first seen near Wilberforce, and thence runs in a south-west direction, parallel to the I. B. & O. Railway, as far as lot 13 of range IX., where it bends back upon itself, and, passing a little to the west of Hotspur P.O., runs in a north-east direction for four miles. This band has been traced continuously for a distance of ten miles. It wraps around and forms a border to a large granite intrusion, often pegmatitic in character. To all appearance it is a differentiation-product of the granite magma. In fact, nearly all the occurrences of nepheline-syenite that have been found in the present sheet (No. 118) bear a similar relation to granite masses. Not to mention

Nepheline-syenite.

Its relation to granite magma.

the occurrences in the Bancroft district, described in a former report, there may be cited as example, an occurrence discovered last year on lot 26 of Faraday, on the line between ranges A and B. This occurrence, which is at least one hundred yards wide and holds sodalite, lies on the margin of the great mass of granite forming the northern half of the township of Faraday and between it and a great development of crystalline limestone in the western portion of the township. Another similar occurrence of nepheline-syenite was found on lot 15 of range I, of the township of Harcourt, and is well exposed in a cutting on the I. B. & O. Railway. It again occurs at the contact of the great mass of granitic rocks occupying the northern part of the township of Cardiff and the crystalline limestones of the Grenville series which sweep around it.

Further occurrences of nepheline-syenite.

" Still another great development of nepheline-syenite intimately associated with granite, is that composing the Blue Mountains, a long range of hills running north-east and south-west through ranges VI. to XII. of the township of Methuen. These rise from a great granite plain, and the petrographical associations are of extreme interest but require further study before they can be clearly made out.

" In addition to the band of nephline-syenite above described, from Monmouth, there is also in the same township an isolated area of considerable size situated on lots 9, 10 and 11 of ranges VII. and VIII. where it breaks through the limestone of the Grenville series.

Association with corundum.

" The occurrence of nepheline-syenite in Methuen, referred to above, is of especial interest from an economic standpoint on account of the occurrence of considerable deposits of both muscovite and corundum in the pegmatite veins and coarse segregations occurring in it or in its immediate vicinity. In fact, corundum has been found so generally in connection with the nepheline-syenites occurring in the north-eastern portions of the sheet, that all the areas of this rock above mentioned are worthy of being very carefully searched for this mineral.

Economic minerals.

" A large number of mineral deposits occurring in the district examined were carefully investigated. These consisted of deposits of graphite, apatite, mica, corundum, iron-pyrites, molybdenite, etc.

Mica.

"The only deposit of mica that was being worked in the district examined, is situated on lot 7 of range XXII. of Cardiff, by the side of the I. B. & O. Railway track. This deposit is owned by Messrs. Best and Membry. A pit twenty feet square and eighteen feet deep had been made, and a considerable amount of mica, in sizes up to two feet by two feet and a half, had been extracted. The mica is dark in colour, and occurs in a mass of the granular green pyroxenite, so frequently found, as in this case, associated with the limestones of the

Grenville series. Similar dark-coloured mica, in large sheets, has been discovered on lots 30 and 31 of range XIII. of Cardiff, as well as amber mica of good quality, but of smaller sizes, on lot 31 of range XII. of the same township. The mica deposits of Methuen, mentioned above, are, however, no longer worked. Work on the corundum deposits had also been suspended at the time these were visited.

Molybdenite.

"Fine specimens of molybdenite are to be obtained on range I. of the township of Harcourt, at a point which is probably situated on lot 3. The country-rock is a granular green pyroxenite, which has been produced by the complete alteration of an isolated mass of limestone inclosed in the Fundamental gneiss. This pyroxenite is traversed by little strings of pyrite and molybdenite, associated in places with pyrrhotite, tourmaline, sphene and other minerals. A pit about fifteen feet deep, has been put down on the deposit by Mr. Gordon, of Toronto, and a considerable amount of pyrite, said to contain gold, has been raised, as well as a small amount of molybdenite.

Quartz veins.

"Samples of quartz collected from the Higman mine, on lot 9, con. VII. of Limerick, assayed in the laboratory of the Survey, proved to contain no gold, and only 0·175 of an ounce of silver to the ton of 2000 lbs.

"Other samples collected from large irregular masses of quartz cutting crystalline limestone on lot 31, con. VI. of Cashel, were found to carry neither gold nor silver."

QUEBEC.

Work by Dr. R. W. Ells.

The winter of 1897-98 was spent by Dr. R. W. Ells in plotting and compiling the notes of field-work of the preceding season, and in laying down the geological lines on map-sheets Nos. 119 and 120. Considerable time was also devoted to work upon a proposed special map of the Ottawa district. Dr. Ells' field-work, during the summer, was carried on partly in Ontario but chiefly in Quebec. Surveys and examinations were made within the area of map-sheets 119 and 120, now in course of compilation, for the purpose of completing the necessary information for these sheets. Dr. Ells was also requested to undertake the preparation of a general explanatory report to accompany the Three Rivers sheet, or north-west sheet of the series of four which has generally been referred to as the "Eastern Townships," series. This involved the correlation of much work previously done by other members of the staff, and necessitated some further surveys and examinations for this purpose. The map-sheet is now in the

engraver's hands for completion. On his field-work, Dr. Ells reports as follows :—

Various surveys.

"Several weeks of May and June were spent in completing the examination of certain areas, lying to the south of the Bonnechère and Madawaska rivers in Ontario, and in correcting the surveys of the townships of Hull, Eardley and Onslow, in Quebec. On the 28th of June, I set out for the St. Maurice district, in order to complete if possible, the series of surveys which had been partly made in that area several years before by Messrs. Adams, McConnell, Giroux, Ord and Low, in connection with the geology of the north-west map-sheet of the 'Eastern Townships' series, the report on which, owing to various causes, had not been prepared for publication. A report on a portion of this area, embracing the south-west corner of the sheet, had, however, been published in 1895 by Dr. Adams, in connection with his report on the anorthosite masses of that district.

Work in St. Maurice district.

"In carrying out this scheme of work, after several days spent in the vicinity of Joliette, St. Gabriel de Brandon and the country to the north and east of that place, I left for the village of St. Michel des Saints, about sixty-five miles north. This place is situated on the upper part of the Matawin River, which is the principal tributary of the St. Maurice from the west.

Ascent of Post River.

"Here men were engaged, and early in July I began the ascent of the Post River which was followed up to its head in Lake Clear. Thence, by a portage of half a mile, the waters of Vermilion River were reached, and these were followed north to a further distance of twelve miles through a chain of lakes. The country in this direction was found to be generally nearly level, characterized by great areas of sand and gravel with but few rock-exposures. Clear Lake, at the head of the Post, is of large size, with generally sandy shores ; the only rocks seen being grayish and reddish banded gneiss.

Rocks near Post River.

"Along the Post River also the shores show comparatively few rock-exposures, and these are of the upper or grayish, often rusty, gneiss series. About two miles below Clear Lake, a small band of crystalline limestone shows in the stream, and some scattered blocks extend for several miles below this place. On a small lake to the east (Jerome Lake), reached by a portage which is about one mile north of the forks of the Long Lake River, the gneiss, which is of the usual gray and reddish variety, and is cut by red granites, contains a broad belt of almost pure quartz. This band is white, with a breadth of at least fifty feet, and its lower portion, near the contact with the red granite, carries a quantity of black and broken crystals of mica. Masses of

clear red felspar are distributed through the quartz. The mica is of no economic importance, although spoken of as a 'mine' by the hunters.

"Returning down the Post, the west branch, known as Long Lake River, was ascended to Lake Croche, the stream being in places very rough and the portages bad. From Lake Croche a portage of nearly a mile leads to Long Lake, and from the head of this lake, Lake Travers, the source of this stream, is reached. On Lake Croche, crystalline limestone occurs at several places along the east shore, but the prevailing rock is a reddish granite-gneiss, foliated, coarse-grained and rough-weathering. Along the stream below this lake large areas of reddish augen-gneiss with a well-defined foliation were seen. Long Lake River.

"On the long stretch between this lake and the head of Lake Travers, much of the rock seen is a foliated red granite; but several outcrops along the upper portion of the route are of reddish-gray and gray garnetiferous mica-gneiss. Glacial striæ were noted at several points with a course of S. 10° W. About Lake Travers masses of red foliated gneiss occur. From the head of this lake a portage of three-fourths of a mile leads to Lake Sassiakinagog on the upper waters of the Manuan River where also grayish mica-gneiss, with black hornblende bands, appears, with a strike a few degrees east of north. Lake Travers.

"Sassiakinagog Lake is eighty feet lower than Lake Travers. It is a large sheet of water with long arm-like bays. The prevailing rock is grayish and reddish-gray gneiss, but there is also a large development of grayish quartzite like that seen along certain parts of the Lower Ottawa. This rock extends along the north shore of the lake for several miles, and though several blocks of crystalline limestone were seen, no ledges of this rock were noted. Much of the shore is, however, low and without rock-exposures. Sassiakinagog Lake.

"Following Pasquatazebe Creek from the south-west end of this lake, we reached the height-of-land between the Manuan and the Matawin at the head of the north-east branch of the Milieu. The country along this stretch is generally low and the shores of the creek are swampy, only one outcrop of rusty quartzose gneiss being seen. The lake shores along the upper part, however, show many large boulders of reddish gneiss and granite. Thence to River Milieu.

"The Milieu flows, for most of its course, between low and sandy or bouldery banks, the upper portion of the valley is swampy and the stream is choked with thick alders. Heavy rapids are frequent and are often caused by boulders, of large size, but rock-ledges are not very numerous. Where seen these ledges are of gneiss of the usual Grenville type, sometimes with areas of gray quartzite. Though no River Milieu.

limestone was seen along the stream, several outcrops of this rock are found both to the east and west of this river, at a distance of ten to twelve miles from its mouth. These outcrops may be the extensien of certain bands seen along, or in the vicinity of, the Matawin, below the village of St. Michel, and which there have a strike to the west of north, in the same association with rusty gneiss so frequent in the Grenville district. Along the lower part of this stream, not far from the limestone bands, there are several deposits of mica which in former years were mined to a slight extent, but have long been abandoned. Apatite also occurs with the mica, the containing rock being a greenish pyroxenite, as is the case in the Ottawa district. The lower part of this stream, flows through banks of sand for several miles till it enters the Matawin about eight miles below the village of St. Michel.

Upper Matawin.

"The south branch of the Matawin or Cypress River was next ascended, to the head of Cypress Lake. This lake is about six miles in length and is bordered by high hills and ridges on the south and west, which separate its waters from those of L'Ouareau River and from the head of the L'Assomption River. Portages extend from the south end of this lake to both these places. The character of country in this direction is very much like that seen about Trembling Lake on the Rouge River. The rocks around Cypress Lake are for the most part grayish and reddish-gray gneiss, often garnetiferous, having a strike of N. 65° W. with a dip to the south-west. In places the gneiss is quite rusty, and quartzite also occurs, but no limestone was seen in this direction. A portage from the north-west angle of the lake leads across to Devil Lake on Devil River, which flows into the Rouge.

North-west branch of Matawin.

"The upper or north-west branch of the Matawin, above the Cypress branch, is formed by the confluence of two streams, each of which extends for about thirty miles northward, flowing generally through low and often swampy country. They are said by the hunters to show solid rock, the banks consisting for the most part of sand and gravel, with stretches of beaver-meadows, and they were therefore not followed. Descending the river again to St. Michel, traverses were made to lakes Trefle and Proteau and to the chain of lakes along the south-east border of the township of Provost. The same kind of grayish, often garnetiferous and quartzose gneiss, was observed on all these, and bands of impure limestone were noted on several of them. Mountain masses apparently of reddish foliated granite are seen in parts of this area. The gneiss strikes generally to the north-west and the dip is usually to the south-west. The rocks are in places much disturbed near the granite masses.

"Surveys were made of the roads in the vicinity of the Matawin, both to the east and west of St. Michel, after which I began the descent of the Matawin to the St. Maurice. In this traverse an examination was made, for the sake of comparison, of the rocks along the lower part of the Eagle River, on the north side, and further down, of the Antikagamak Lake and of Lake Wapizagonk on the headwaters of the Shawenigan River.

Descend the Matawin.

"Returning to the Matawin, we descended that river to the head of the Cinq Rapids, from which point a portage-route of about three miles leads across to the Cinq lakes. The Matawin below this point is very rough, with heavy rapids, so that it is very rarely traversed. This part was, however, surveyed by Mr. Ord in 1880, so that our section along this river is complete.

Cinq Lake.

"The portage to the lower Cinq Lake is over a ridge of grayish, sometimes garnetiferous gneiss. Along the lake, good exposures are seen near its lower end and in the east bay. The rocks are grayish gneiss with a very low dip to the east, the angles being rarely more than five degrees. Several low undulations are seen and bands of a coarser red gneiss, as well as of black hornblende, appear on the east bay. This chain of lakes was followed south to its head, and a portage made to the head of the chain of the Fishing lakes, whence a route extends out to the St. Maurice at the village of Grandes Piles. These lakes are leased by the Laurentian Fishing Club, by which good portage-routes have been opened to a number of the surrounding lakes. In all these, however, there appears the same character in the rock-exposures. They are all gneiss of the upper or Grenville series, with occasional areas of granite. The dips are everywhere at low angles, but several anticlines traverse the district.

Fishing lakes.

Character of the country.

"Throughout all this Matawin country, with the exception of the small settlement near St. Michel, there is no means of communication except by canoe. The whole country is one unbroken wilderness, abounding in deer, caribou, moose and bears. Beavers are still numerous in most of the streams and the traces of their presence may be frequently seen in the shape of houses and dams. The whole district is densely wooded, though most of the growth is small, owing to a fire some years ago that swept off much of the timber along the course of the river for many miles.

Geology.

"The geology of portions of this district, both to the north and south of the Matawin, had already been examined by Messrs. Giroux and Adams, and also in 1880 by Mr. Ord. On reaching Grandes Piles, it was my intention to make an examination of that part of the St.

Maurice extending thence up to the mouth of the Vermilion River, to see how far the gneisses of the Grenville series there run, but a severe attack of lumbago, contracted while descending the lower part of the Matawin, rendered further exploration in this direction impossible. The examination of the area to the east of the St. Maurice had, for the same reason, to be abandoned, but as this portion had been traversed by Mr. A. P. Low, in 1891, this will not be necessary, as his notes on this district are so full that the geological structure of the area can be readily understood.

Surveys made in the autumn.

"Returning to Ottawa, the remainder of the season in the field was devoted to the completion of the surveys in the townships west of the Gatineau, and along the north side of the Ottawa River. In this connection a further examination was made of the geology of Calumet Island, where important deposits of blende and galena have been mined for several years, and where a new deposit of nickeliferous pyrrhotite has been recently discovered.

"Further examinations were also made in the area to the south of the Rideau River, in Gloucester township, and a well-defined line of fault separating the Calciferous limestone from the Utica shales was located on lot 14, range IV. of that township. The beds of the former are there tilted up to an angle of 65° and certain portions of the strata in the vicinity are cleaved at right angles to the bedding.

"The surveys in the townships of Nepean, North Gower, Goulbourn and Marlborough were also carried on sufficiently to ascertain the geological structure of this area, and to connect the work of the previous season with the former surveys in the immediate vicinity of Ottawa. Several faults were found in this district, separating the Calciferous from the Trenton and Black River formations.

Results obtained in St. Maurice district.

"The results of the examinations in the St. Maurice district may be briefly summed up, preliminary to the general report on the area now being prepared. In character, the gneisses, quartzites and limestones are similar to those of the Ottawa district, and it would therefore appear that all the rocks from the Palæozoic of the St. Lawrence basin, northward for some distance beyond the northern limit of the map-sheet, belong to the Grenville series rather than to what has been called the Fundamental gneiss. With these, however, are associated masses of newer intrusive rocks, such as anorthosites, granites, syenite and augen-gneiss, some of which constitute areas of large extent and can be depicted on the map. In other cases such are the difficulties of access that the outlining of these masses must be largely conjectural.

"The crystalline limestones have but a small development and occur at widely separated localities. Bands cannot be traced continuously from point to point for any considerable distance, as the outcrops are sometimes abruptly cut off by intrusions, or thin out of themselves. In places their tracing is prevented by the great expanse of sand and gravel drift. Certain of these reported bands of limestone can scarcely be regarded as other than calcite masses, which are a part of the pyroxene rock with which they are associated; and in this case are not an integral part of the gneiss and quartzite series. Those noted along the upper portion of the Matawin are, however, like the Grenville limestones. The largest development is in the township of Polette near the St. Maurice, where there is a reported breadth of from 200 to 400 yards, extending for several miles along the strike. East of this river true limestones are rarely seen, though the gneisses are of the same general character as in the area to the west of the river.

Crystalline limestones.

"The garnetiferous gneiss has a wide distribution. It can be recognized at all points in the area of the north-west map-sheet. It is associated with grayish and reddish-gray gneiss, and often with schistose bands, as is the case with the bands to the south of the Ottawa, in Renfrew county. The rocks lie in a series of low anticlines, the dips being generally from five to twenty degrees, though sometimes, in consequence of breaks or faults they become vertical. Owing, however, to the mantle of drift, these anticlines cannot be definitely traced for long distances. The banding of the gneiss, as in the Ottawa district, is north, varying a few degrees on either side.

Garnetiferous gneiss.

"Economic minerals are apparently rare in this district, with the exception of the deposits of bog-iron ore, which are found at many widely separated points. The distribution of the principal deposits has already been noted in the summary report of Mr. Low for 1891. Along the upper part of the Matawin small quantities of mica and apatite are seen, but the quality and quantity are not such as at present to render their mining profitable. These deposits have been described in the summary report of Mr. Giroux for 1891-92.

Economic minerals. Iron ores.

"Small quartz veins are seen at many points in the gray gneiss and are supposed by the settlers to indicate gold. In all the cases examined, the only mineral seen was iron-pyrites, which is sometimes found in small quantity. On the upper part of the L'Assomption River, near the forks, bands of serpentine are associated with crystalline limestone, and these sometimes carry small veins of chrysotile, similar to those seen along the lower Ottawa. From the narrowness of the veins exhibited

Quartz veins.

Chrysotile.

as well as from the inaccessibility of the area where these occur, the economic importance of these deposits doubtful.

Limestone.

" Near St. Michel, some of the limestone bands are locally utilized for lime-burning. A deposit of ochre on the lower part of the Milieu, at the last rapid before reaching the Matawin, appears to be of good quality, but is too far from means of transport to be worked except for local purposes. The garnets in some of the gneiss bands in this area are remarkable, both for the large size of the crystals, some of these being fully an inch in diameter, and for their abundance.

Garnets.

" The general geological features of the greater portion of this area have already been described in the summary reports of Messrs. Low, Giroux and Adams and need not be further referred to in this place.

Mica.

" In the area along the lower Gatineau, mica mining has again been resumed. In the township of Wright, the mine opened some years ago by the Rev. Father Guay, of Gracefield, on lot 15, range II., which was closed for some time, has been reopened, and large quantities of mica of good quality are now being extracted. The pit in September, was down to a depth of forty-five feet, and the crystals were very abundant. They were distributed through a mass of grayish and pinkish calcite in a pyroxene rock which cuts the gray gneiss. About three and a half tons of mica per week were being taken out at the date of my visit.

" Along the river between the Pickanock and Aylwin, several other deposits of this mineral are now being worked. These are all in pyroxene-rock and the prospects are good for favourable returns, though the colour of the mica is in most cases very dark. There is a large development of pyroxene along the Gatineau in this area and mica deposits are numerous.

Mining at Calumet Island.

" The most important mining developments along the lower Ottawa, at present, are on Calumet Island. Here the old workings on the Lawn property, near the east end of the island, on blende and galena deposits, have been extended, and development work is now carried on over three lots on range IV. The containing rocks are largely dioritic, with some reddish granite, and these masses are intrusive through the gray gneiss and limestones. These latter are well exposed along the Roche Fendu channel of the Ottawa on the south side of this island. The principal workings at present are on what is known as the Bowie property, where a large open-cut has been made on an ore-body in the diorite, that carries both blende and galena. The ore-body is of considerable extent, but is pockety in its character, and no well-defined hanging or foot walls were seen, though the mass sends off spurs into the enclosing diorite. Over 1000 tons

Lead and zinc.

of ore was mined at this place during the past summer, and the ore finds a ready sale in the European market. On the west part of the area a shaft has been sunk to a depth of nearly 130 feet, in order to cross-cut and intersect several masses of ore that appear at the surface in this vicinity, but work on this location was suspended during the season in order to fill orders from the Bowie pit. There is evidently a large quantity of mixed blende and galena ores in the intrusive rocks of this district, but in none of the openings examined was any well-defined vein structure noted, the ore everywhere appearing rather in pockety masses, though some of these are of large extent.

Nickeliferous pyrrhotite.

"About three miles to the north-west of this mining area, on lots 11 and 12, range IX., another interesting deposit of mineral has recently been opened on the property of Mr. E. P. Cowan. The ore here is different from that on the eastern end of the island, being mostly a pyrrhotite, which carries both nickel and cobalt. The associated rocks are diorites that cut a series of gray and rusty gneisses and crystalline limestones. A large knoll of the diorite rises to the south of the ore-bed, which has a thickness of about twelve feet, and between it and the diorite mass is a band of crystalline limestone. The ore itself is associated with another band of diorite that apparently traverses gray gneiss, the latter being seen beneath or to the north of the ore deposit. On the river a short distance to the south of this mine, the formation is mostly a crystalline limestone, and the intrusions of diorite and granite in this rock can be readily seen. The bed of pyrrhotite at the Cowan mine dips to the south at an angle of about 50°. A shaft has been sunk to a depth of about forty feet and cross-cuts has been made to test the thickness of the deposit.

"Between this place and the Lawn property, there are several points at which mineral indications have been noted, but little attempt has as yet been made to ascertain their value.

Mica.

"Mining for mica is also being carried on along the north side of the Ottawa between Bryson and Coulonge, to the north of Calumet Island, where several deposits of this mineral have been discovered. The work on these, however, is so far largely preliminary, and nothing definite as to the value of the properties can be here stated. In this area most of the mica is of the dark-coloured variety.

"The season's work extended from May 16th to Oct. 1st."

Work of Prof. J. A. Dresser.

Professor J. A. Dresser of St. Francis College, Richmond, Que., having offered to undertake a detailed investigation of Shefford Mountain, with a view to the presentation of a report on the petrography of the mountain to the Geological Survey, has, during the past summer,

been accorded some slight assistance in the prosecution of this work. Prof. Dresser had previously familiarized himself with the general features of the rocks of Shefford Mountain, and it appears probable that his further examinations will enable this isolated mountain mass to be described as a useful type, illustrating the structure and composition of other similar elevations of the St. Lawrence plain in Quebec. Professor Dresser contributes the following notes on the progress of his examination :—

Structure of Shefford Mountain.

"From a review of the work now done, it is clear that Shefford Mountain, as has long been known, is chiefly an igneous mass of later age than the surrounding sediments, which are much disturbed and altered at the contact. The latest of these sediments is the Farnham black slates (D 3a, G.S.C. map of 1896).

"The mountain itself and most of the later dykes in it, share in the general foliation of the region, viz. : that of the Appalachian system.

Relation of stratified to intrusive rocks.

"The evidence is also very strong, if not conclusive, that the mountain is an uncovered laccolite, rather than a volcanic neck. The sedimentary rocks dip away from the igneous on all sides at high angles, showing an arching rather than a breaking-through of the sedimentary rocks.

"Patches of stratified rock frequently overlie the igneous rocks. Such are lithologically similar to the other sedimentary rocks of the district. One of these is an area of slate, at least a quarter of a mile in extent and probably a hundred feet in thickness, and overlies a part of the two latest rocks in the mountain. It forms a sort of cap on the highest peak of the mountain, is altered at its contact with the underlying igneous rocks, and is cut by dykes from each of them. Also, on the leeward side of the course of the chief glaciation, the sedimentary strata still stand leaning against the igneous rock to a height of 1000 feet (by aneroid) above the base of the mountain and about 200 feet lower than the overlying slate just mentioned.

Denudation.

"The amount of the denudation of the sedimentary rocks over the surrounding plain, must have been very great, at least 1000 to 1200 feet of their thickness having been removed. A small lake, half way up the north-west side of the mountain is of glacial origin.

Various igneous rocks.

"The igneous rocks are of at least three different ages of intrusion, besides later dykes of two or else three different ages :—

1. A rock of the gabbro family.
2. A syenite, having varying characteristics.
3. A kind of porphyrite.

"The relative ages of these rocks can be clearly seen at numerous contacts which are well exposed. Also, large numbers of dykes of each of the later rocks are found cutting the preceding one or ones.

"There is also a mica-syenite which is cut by Nos. 2 and 3, but I did not ascertain its relation to No. 1. It may form a fourth number of the series.

"No tufaceous or amygdaloidal rocks could be found.

"None of those rocks show any near relation to a collection made on Mt. Orford two years ago between Eastman and Miletta, a section mentioned by Dr. Ells.

"The later dykes which cut both mountains may be more alike. Those in Shefford Mountain appear to be two kinds. They seem to correspond more or less closely to the dykes of Lake Champlain described by Prof. Kemp and others in publications of the United States Geological Survey."

During the winter of 1897-98 Mr. R. Chalmers was engaged in completing for publication a general report, embracing the detailed work of three seasons, on the surface geology and auriferous deposits of south-eastern Quebec. This report is now in press and will shortly be issued, accompanied by a map showing the gold-bearing belts of the region. **Work by Mr. R. Chalmers in Quebec.**

On field-work carried on in Quebec, Mr. Chalmers reports as follows:—

"In accordance with your instructions I left Ottawa on the 6th of June and proceeded to the county of Portneuf, in the province of Quebec, to examine and report on a very remarkable landslide which had occurred there during the previous month. Mr. J. Keele, of the Geological Survey, was sent with me to photograph some features of this landslide, and a survey of the pit or chasm caused by it was also made. **Examination of landslip in Portneuf.**

"The landslide referred to took place in the parish of St. Thuribe, on the east bank of River Blanche, a tributary of the Ste. Anne, at a point about three miles north of the village of St. Casimir. We reached the spot on the 7th of June and set about collecting all the information we could concerning the catastrophe. Mr. Keele made a paced survey of the area of the landslide and took more than a dozen photographs at points selected by me. The depth of the pit below the general surface of the terrace in which the *débâcle* occurred was likewise measured and the gradient of the bottom approximately ascertained by aneroid readings taken at different points. Mr. Keele returned to Ottawa on the 10th of June,

while I remained a day or two longer to examine some features of the locality and also to visit the scene of another remarkable landslide which occurred on the Ste. Anne River, north of St. Albans, about seven miles above St. Thuribe, on the 27th of April, 1894. After this I proceeded to Quebec.

Character of the landslip.

"The River Blanche landslide, according to the reports of the farmers and others living in the vicinity who witnessed it, took place on the morning of the 7th of May, 1898, between half-past five and nine o'clock. These people, as they arose and looked out were terror-stricken to behold the earth moving from under them, not *en masse*, but piece by piece, and floating off in a stream of semi-liquid mud towards a gap in the river's bank through which it passed into the valley of the Blanche. The river-valley is here bordered by terraces of Leda clay and Saxicava sand, which, previous to the landslide, stood from twenty-five to thirty-five or forty feet above the river-bed. In about three hours or three hours and a-half, a portion of the terrace eighty-six acres in extent and from eighteen to twenty-five feet in depth was thus broken down and the larger part of it swept through the narrow opening referred to into the valley, filling it up nearly to the level of the bottom of the pit from which the material came. It seemed as if there had been a reservoir of soft clay here in a flowing state, which, breaking through the border of the basin enclosing it at the point of least resistance discharged into the valley of River Blanche in the manner described, carrying with it, for greater or less distances, the upper and more coherent clay in masses of various shapes and dimensions. These masses appeared to have split off vertically from the walls of the pit as the lower part slid away from beneath, and frequently exhibited a columnar structure. The larger, which were irregularly pyramidal in form, occasionally became stranded, and presented abraded and striated sides from the passage of other clay blocks. In these stranded masses the strata were observed to be still in a horizontal attitude. The smaller masses were borne into the valley by the torrent of mud. The number of clay blocks, great and small, irregularly distributed in the pit, gave it the appearance of a wilderness of mounds, cones and pyramids; while the quantity of material (chiefly Leda clay) discharged into the valley of the Blanche was found to occupy it for a distance of nearly two miles to a depth varying from ten to twenty-five feet.

Its effects.

"In the destruction caused by the landslide one child, a little daughter of Phileas Douville, lost her life, portions of two farms were ruined, two dwelling-houses, a school-house, two barns and a number of outbuildings were buried in the *débris*, and a large number of logs that lay in the Blanche were covered up by the clay and sand.

"As this singular phenomenon has been personally investigated and described in detail by Dr. G. M. Dawson in a paper read before the Geological Society of America, at the meeting held in New York, on December 28th to 30th, 1898, it is unnecessary for me to say anything further concerning it here.

Landslip at St. Albans.

"The landslide that occurred near St. Albans, four years previously, was somewhat different from that of River Blanche. At the first-mentioned place, the clay and sand moved directly off the west bank of the Ste. Anne into the valley and diverted the river from its former course. The length of this slide was about three miles and a-half, the width about one mile, and the depth ranged from ten feet in some places at the upper part to two hundred and fifty feet along the river. Soon after it took place Messrs. P. S. Archibald and W. B. Mackenzie, of the Intercolonial Railway Engineers' Office, Moncton, N.B., visited the locality, and made a survey of it. Mr. Archibald very kindly sent me copies of his plans, and a brief report of his observations. Mgr. Laflamme, of Laval University, Quebec, also made a survey and detailed examination of this landslide and read a paper concerning it before the Royal Society of Canada, illustrated by a map and diagrams*.

Observations by Sir W. E. Logan.

"This catastrophic and apparently little known form of denudation has called attention to the fact that the landslides above described are not altogether new in the St. Lawrence valley. A pit produced by one of these was noted by Dr. Dawson, immediately to the north of that of St. Thuribe, the approximate area of which is given on the plan of that landslide. Sir W. E. Logan also recorded the occurrence of one which took place on the bank of Maskinongé River on the 4th of April, 1840, in a paper read before the Geological Society of London†. It seems that a mass of sand and clay covering an area of about eighty-four acres was moved to a depth of nearly thirty feet, piece by piece endwise, through a narrow opening into the river-valley there also in about three hours. From Logan's survey of this slide, during the autumn after it occurred, and his description in the paper cited, it must have resembled that of River Blanche very closely.

Heights of terraces.

"After the investigation of the landslides at River Blanche and St. Albans, I proceeded to the south side of the St. Lawrence valley to level the Pleistocene shore-lines there, commencing at Lévis and vicinity and going westward. The elevations of these had previously been ascertained approximately by aneroid; but it was considered desirable that at certain points, where they were well-defined, levellings with a

* Trans. Royal Society of Canada. Vol. XII., 1894. Sec. IV. pp. 63-70.

† Proceedings of the Geol. Soc. of London. Vol. III, 1838-1842, pp. 767-69.

spirit-level from the nearest railway stations should be undertaken. Work of this kind was begun at St. Anselme Mountain, fifteen miles south-east of Lévis, and continued westward as far as Shefford Mountain at West Shefford station, Canadian Pacific Railway, interrupted a good deal, however, towards the end of June by wet weather. A few days were then spent at Dudswell in a re-examination of the gold-bearing rocks of that place and in securing samples for an assay and mill test.

HUDSON BAY.

Work by Mr, A. P. Low.

After the first pages of this report were ready for press, a letter was received from Mr. A. P. Low announcing his safe arrival at Great Whale River, giving the main results of his explorations during the past summer and outlining his plans for the coming season. It is thus possible to include the essential parts of this interesting communication, from which it appears that Mr. Low has been able to make very important additions to our geographical and geological knowledge of the east coast of Hudson Bay. Mr. Low writes as follows :—

Difficulties encountered.

"I am happy to state that my party have been in good health and that we have had a successful season, although not doing as much work as I had intended, owing to the continuous bad weather during September, when we had a succession of gales from all points of the compass. Another cause of delay was the unexpectedly shallow water found everywhere along the coast from within a few miles of Cape Wolstenholme to Portland Promontory. This stretch of coast resembles that of the east coast of James Bay, being very low, almost flat and fringed with small islands, with shallow water and a very uneven bottom extending several miles off shore. The islands and shoals are largely formed of boulders (morainic material) which appear to have been shoved up into sharp lumps by the grounding of heavy ice in the shallow water. We ran aground several times even when sailing slowly with a good look-out, and it was only good luck that prevented serious consequences on two occasions, when we were aground for several hours and only got clear by removing the cargo and ballast, as the tide rises so little that it is practically useless to depend upon it to float the yacht. Owing to the above causes we did not reach Portland Promontory until the 9th of September, when I considered it too late in the season to attempt the exploration of the outer islands, and in this I was right, as the weather continued very stormy for the next three weeks, and it is doubtful if we would ever have arrived here had we gone to the northern islands,

Shoal coast.

Consequent delays.

which I have since learned are nearly all low and largely formed of drift material, without harbours and surrounded by shallow water and shoals, resembling the coast to the northward. Instead of going to the islands we continued the log-survey down the coast to Great Whale River, and, as you may see from the accompanying reduction of the survey, have made some additions to the previous track-survey of this part of the coast.

"As I wrote you, Capt. Gray of the *Erik* thought it better to land us near Cape Wolstenholme rather than at Port Laperriere, and as the conditions were favourable I agreed with him, so, on the morning of August 1st the *Erik* came to anchor near the head of a small bay just east of Cape Wolstenholme and remained there until evening, allowing us to rig and load the yacht, which had been put overboard the previous evening and towed behind the steamer. The following day, while the men were completing the rigging, etc., Young and I were engaged in making observations for latitude and longitude, and also in examining the country and rocks in the vicinity. The coast about here is high, rising abruptly from 800 to 1000 feet above the sea and then more gradually inland to a general elevation of about 1500 feet, being on top a succession of low, rounded, glaciated hills. Terraces occur on the flanks of the hills more than 700 feet above the present sea-level. There were considerable patches of snow everywhere, but most of it was old, as the spring had been early and hot, and so nearly all the previous winter's snow had already melted. While climbing the hills I shot two barren-ground caribou, thus giving us a supply of fresh meet to begin with. These animals are very numerous about here and along the coast for about fifty miles to the southward of Cape Wolstenholme, and we frequently saw small herds along the land-wash as we passed in the yacht. Beyond this they are not common along the coast, but occur plentifully some miles inland all the way southward to the wooded country near the Nastapoka River. The Eskimo leave the coast early in August, going inland to kill deer for food and winter clothing, and remain in the interior until December, when they slowly make their way southward to Great Whale River, trapping foxes as they move along.

Work begun at Cape Wolstenholme.

High land near the cape.

Caribou.

"On the 3rd of August, we sailed past Cape Wolstenholme, but only got to a small cove about four miles beyond, owing to light winds. The channel between the mainland and the eastern Digges Island is less than two miles wide; the tide sets strongly through it, and there was considerable loose ice floating about when we passed".

Round the cape.

"Wolstenholme terminates in a small point about 200 feet high, immediately backed by jagged perpendicular cliffs composed largely of

Character of the point.

rusty-weathering dark mica-gneiss, on edge. The cliffs are about 1000 feet high, and are full of crevices where the murre (Brunnick's guillemot) breed in tens of thousands; each bird lays a single egg on a narrow ledge, over which it straddles, and we could approach within ten feet without disturbing them. The noise of the birds' wings when a gun was fired was like heavy thunder, and the first time I fired I dodged behind a mass of rock, thinking that the report had dislodged a large piece of the cliff above. These birds also breed in great numbers on Digges, but were not seen to the southward; I think that they do not leave Hudson Bay, for the Eskimo say great numbers pass the winter in the open water outside the outer islands.

Guillemots.

"The perpendicular strata of dark, schistose mica-gneiss (Grenville series) often contain much disseminated pyrite, and some beds are graphitic, but there is no limestone. These rocks are cut by masses of pink and red mica-gneiss and mica-hornblende-gneiss which is intruded into the darker gneisses.

Eskimos.

The next two days were quite calm and we remained at anchor, making excursions inland and examining the brooks for possible traces of gold, but without success. While here we were visited by seven Eskimos in kayaks and I engaged one as guide to the first river to the southward. They are encamped in the same place, Nuyuk, where Dr. Bell visited them, some fifteen miles west of Wolstenholme.

"On the 5th we picked up our guide and made about five miles more, when the ice gradually closed and forced us into a little cove where we remained ice-bound until the 8th, when the wind set the ice off the coast and we had no more bother with it, the last being seen on the 10th.

Lower land to the south.

"The coast where we were ice-bound is much lower than about Wolstenholme, the cliffs have totally disappeared, and the land rises gently from the shore into rounded hills (200–500 feet) composed largely of drift, with rock showing only on the summits and points. Beyond this, to within a few miles of Cape Smith, the coast and country in rear are very low with few rock-exposures; these being nearly all granitic gneiss with broken bands of schistose mica-gneiss and of altered basic irruptives. At Cape Smith and along the north side of Mosquito Bay, a range of high hills reaches the coast from the north-east. These hills on the coast vary from 500 to 800 feet, but inland rise above 1000 feet.

Trap hills

They are formed of trap, usually fine-grained and frequently having large cavities filled with calcite and quartz, and sometimes short irregular veins of these minerals. In places the rock is a fine-textured

green diabase, weathering to a rusty-brown. It is nearly everywhere jointed in such a manner as to give the mass a rough basaltic structure, by dividing it into rude, irregular prisms, which are inclined at all angles to the horizontal. In many places the outsides of these prisms are altered to a depth from one to three inches into a dark-green crystalline mineral like hornblende. Along certain lines, especially near a contact with the granite, which is of later date, a schistose structure is developed in the trap. This has flattened and lengthened the prisms, drawing them out into bands and producing schist like Huronian schists, with the dark and light bands formed from the altered outsides and cores respectively of the prisms; while other quartzose bands, holding calcite, are formed from the masses of those minerals already mentioned. I saw this change in all stages in several places on the coast, and it seems to me probable that many of the light and dark banded Huronian schists found so commonly throughout Canada have a like origin and are not true pyroclastic rocks.

Metamorphism of trap.

The hilly country does not extend further than the north side of Mosquito Bay, to the southward of which the coast again becomes very low and is fringed with many islands to Portland Promontory, where highlands again occur. From Portland Promontory to Great Whale River, the coast is bold and rocky, rising in rather sharp irregular hills from 500 to 1200 feet high. These are formed largely of red granitic gneiss, holding numerous large fragments of light-gray quartzose mica-gneiss. The rocks of the coast between Mosquito Bay and Portland Promontory, are also largely granites, holding, in places, broken bands and masses of rusty-weathering and very quartzose mica-gneisses; and along with these in several place, notably near Thompson Harbour, Puvungituk River and Portland Promontory, large masses of dark and banded basic schists (altered traps), gabbro and diabase.

Low country south of Mosquito Bay.

"The unaltered clastic rocks and traps are first seen on the outer islands at Portland Promontory, where the inner islands are formed largely of the same rocks metamorphosed and jumbled up by the intrusion of granite. The Hopewell and Manitounuck Islands are capped with trap, while the Nastapoka chain is without trap and its rocks are probably higher in the series than those of the islands north and south of it. The unaltered rocks occur on the mainland about five miles south of the Nastapoka River and continue to within five miles of Great Whale River. Along Manitounuck Sound, there is an unconformity, or rather, the lower beds are wanting, limestones resting upon the granites; but in several places I found masses of arkose, coarse sandstone and silicious limestone enclosed in and un-

Unaltered rocks first seen.

Junction with granites.

doubtedly older than the granite. These included rocks belong to the lower members of the unaltered series as shown in my section at Castle Peninsula, Richmond Gulf, and consequently, as on Ungava Bay, the so-called Cambrian is older than the granite rocks here and to the northward. * * *

Great deposits of iron ores.

On all the islands of the Nastapoka chain, I found great thicknesses of magnetite and magnetite-hæmatite ores, associated with jasper and similar to those discovered on the Hamilton and Ungava rivers. In places, beds of rich ore were seen more than 40 feet in thickness and the amount of iron here is incalculable. There is also a good deal of silicious ankerite, which, as stated in Dr. Bell's report, contains large percentages of manganese. The magnetite occurs in thinner bands along with ankerite in the Hopewell Islands, but on the Manitounuck Islands there is very little ore. In the areas of altered traps and other schistose basic rocks to the northward of Portland Promontory, pyrite and pyrrhotite are common, the latter ore in large masses occasionally. These masses of pyrrhotite may contain gold or nickel, as they usually occur close to large granite intrusions.

Other minerals.

"Quartz veins are also often numerous in these localities, and may prove a source of gold, although I saw no free gold in any of them during my hurried examinations.

Glaciation.

"These are the principal points of interest in relation to the geology of the region, and it remains only to state that the country was entirely glaciated, with the ice-flow everywhere outwards to the sea, or a little to the north of west. The drift brought down by the glacier-ice forms a great part of the shoals and islands extending for several miles off the coast, and from information obtained from the Eskimos, it would appear that a line of morainic islands extend southward from the neighbourhood of Portland Promontory nearly to Nastapoka River. These islands lie forty or fifty miles off the coast, and may be similar to those of James Bay.

Terraces.

"The post-glacial, or later glacial subsidence along the coast, exceeded 700 feet, and, consequently, a large amount of the present northern land was then under water, leaving the highlands of Cape Wolstenholme and Cape Smith as strings of islands. In a number of places I saw fine examples of striæ produced by floating ice, differing from glacier striæ, in seldom being more than a few feet long, generally curved, and crossing one another at various angles.

Rivers.

"Owing to the want of a guide along this low and broken coast, it was only with considerable difficulty that we found the mouths of any of the rivers, and thus we missed those of the Koghaluk, Puvungituk

and Tuchuchutuk, although we tried to find that of the first-named, and entered bays that must have been close to it on both sides. The Eskimos say the Koghaluk is the largest river on the coast. If it is greater than the Sorehead, it is indeed a large river, as the latter is much larger than Great Whale River. The other rivers are not large or important.

"Considerable attention was given by me to the fisheries of the bay and the following notes on these may be of value. Fisheries.

"I carefully enquired about the common salmon from the Eskimos at Cape Wolstenholme and others to the southward. None of them had ever seen this fish, and, consequently, it may be taken that it does not enter the strait much further than the west shore of Ungava Bay. Salmon.

"Hearne s salmon is probably the most important food fish of Hudson Bay. It is very plentiful along the northern coast from Cape Wolstenholme to Cape Jones, and is especially abundant in the mouths of the northern rivers, where with our small nets we several times took more than thirty fish in a night. They vary in weight from three to fifteen pounds, a good average being six pounds. I have no doubt that this fish would be very valuable if the bay were accessible by railway, as it is not only very plentiful but is much superior in flavour and colour to the lake-trout. Hearne's salmon.

"Sea-trout are common along the coast, especially to the southward of Cape Jones, where they are caught in nets in shallow water between the islands, along with small whitefish. Both species enter the rivers in September and ascend them to deposit their eggs. The trout rarely weigh five pounds and do not average three pounds. Trout.

"As previously stated in my reports, whitefish are caught along with the trout in James Bay and are common along the coast to Hudson Strait. In the northern part, they are larger than in James Bay and were nearly always taken in our nets with Hearne's salmon, when they weighed from three pounds to six pounds. Whitefish.

"I am now certain that cod is not only found in Hudson Bay but that it remains in these waters throughout the year, as I have learned that the Eskimos, along the coast between Great Whale River and Portland Promontory, and those living on the outer islands, make a practice of catching these fish through the ice throughout the winter. The Eskimos of Wolstenholme knew the cod, but rarely fished for them. Those at Mosquito Bay often caught them on hooks, and while anchored at Cape Smith we caught two fish about thirty inches long which my men (Nova Scotia fishermen) pronounced true cod. Cod.

"The shallow water and sandy bottom off the coast to the northward of Portland Promontory are not favourable for cod, but the deeper water and rocky bottoms along-shore to the southward of that place and as far as Cape Jones, together with the rocky inner and outer islands and banks, are ideal places for cod, and they are commonly taken by the Eskimos in these places.

Bait.

"There is a good supply of bait, or food, for the cod, in the caplin, which are often thrown up along the coast. We also took 'lance' in the dredge, together with many sea-urchins, star-fish, crabs, etc., in fact everything that is found on the Labrador coast, except the squid.

Importance of fishery not known.

"Although I do not know the extent of the fishing grounds or abundance of the cod in Hudson Bay, and had no means of determining these points, our boat being too small for fishery work, I think that the knowledge of their presence in considerable numbers throughout the year, points to a practically inland fishery, and is of so great value that these facts should be brought to the attention of the proper authorities, so that an early and complete investigation may be made, with a suitable vessel, of this perhaps important fishery. There is no reason why, in the deeper waters of the bay, halibut may not also be found, although I can hear nothing of this fish from the Eskimos.

"Herring is unknown to the Eskimos, and consequently may be assumed not to occur in Hudson Bay. The only other salt water fishes are two species of sculpin, and small lump-fish, etc., of no economic value.

Seals.

"I do not think that the seal fishery of Hudson Bay will be of commercial importance, although there are plenty of seals along the coast; for, as they never congregate in large numbers to pup, like the harp and hood seals off Newfoundland, the killing of these animals will be left, as at present, to the Eskimos.

Walrus.

"The walrus is not now very abundant, and ivory sufficient for shoeing dog-sleds is difficult to obtain for the Eskimos. I learn that on the outer islands of the North Belchers there are a few 'rookeries' where small herds of walrus remain during the summer, and where they are seldom disturbed by the natives. I hope to know personally about these next summer.

White whale.

"The white whale or 'porpoise' frequents the mouths of the large northern rivers in considerable numbers, and there might, for a time, be carried on profitable fisheries for these animals; but the experience of the Hudson's Bay Co. and others is against a permanent, successful porpoise fishery, as after a few captures they will not enter the rivers.

"Bone whales are practically unknown to the Eskimos of this coast, and what whalebone they may have has been obtained from Eskimos to the northward of Hudson Strait.

"The Eskimos report that the rivers and numerous large lakes of the barren grounds contain quantities of brook-trout and lake-trout, arctic salmon-trout and whitefish. Fresh-water fish.

"Mr. Young has made a large and nearly complete collection of plants. We have also a number of butterflies and other insects, as well as some marine animals obtained by dredging. Meteorological observations have been regularly kept since August 1st, including the surface temperature of the water. Collections.

"We arrived at Great Whale River post on the 25th of September, and were kindly received by Mr. Gillies who placed two rooms in his house at our disposal, and furnished quarters for the men in the servants' house. Mr. Gillies is also assisting us in procuring dogs, guides, etc., for our spring work. Proceedings at Great Whale River.

"Our first care on arriving was the proper housing of the yacht in winter quarters, and we soon had her dismantled and hauled out alongside the Company's craft on a low bank about half a mile above the post. The men were then set to work to make two sleds, before cold weather, and when these were finished, they spent the remainder of October in chopping fire-wood. Early in November I sent Lantz and Ford a few miles to the southward to hunt, as fresh meat is a very scarce article here, and we live largely on salt and tinned meat owing to the scarcity of ptarmigan, hares or deer. Mr. Young has been busy plotting his surveys of the past season, keeping weather observations and other work incidental to the trip. I have developed all the photographs taken and they have turned out satisfactorily on the whole, being better than those of any other season. * * *

"I will now try to give you a short sketch of my present plans in regard to future work. It was intended that the party in the spring should go inland from here and explore the country to the eastward. With such an object in view I wrote to Mr. Gillies to provide Indians along our possible route with nets, so that they might lay up stores of fish for our use as dog-food and also kill deer for the same purpose. The Indians would not take the nets and said that the deer also could not be depended on; consequently, I have no dog-food inland, and cannot, therefore, make any extended stay in that part of the country. Plans for further work.

"As this must be abandoned, I have, after consulting Mr. Gillies and the Eskimos, determined to divide the party, sending Mr. Original plans modified.

Young to the Belcher Islands and going myself northward along the coast some distance past the mouth of the Nastapoka River and then inland about 100 miles to a very large lake, called Eskimo Seal Lake, to explore the country about there on the edge of the barren-grounds. On both these trips seals can be obtained to feed the dogs, while on the coast, and inland, the Eskimo say that sufficient caribou may be killed to keep the dogs going. We shall probably start about March 1st, as previous to that date the short days and extreme cold make dog travelling very slow and disagreeable, and the amount of work done would be inconsiderable and very expensive. The mail packet also does not arrive here until the end of February, and as that will be our first news from home since leaving, eight months before, we naturally want our letters before going off. I expect to be absent until early in April, and Young will probably be away about the same time.

Exploration of Great Whale River.

"On our return, when the travelling on the crust ought to be good, I propose taking the united party inland up this river, and we may be able to go a considerable distance up the main river and perhaps to cross to Little Whale River and descend it to the coast, but this will depend on the information which I may get from Indians expected here after New Year. Travelling on snow and ice is practically over by the 15th of May, and we will then turn our attention to outfitting the yacht for next summer's work. The ice usually leaves the river about the last of May, but it is always two weeks later before the coast is clear of ice, and often the ice does not go sufficiently for boat work until much later. If the season is at all favourable, I propose to go northward along the coast to Richmond Gulf, and then to sail out to the North Belchers and make a survey of them and of the outer islands of the South Belchers, which cannot be reached by Young in the winter owing to the ice not setting fast. We will probably finish with the islands late in July, when we will return here and then proceed southward, carrying on the log-survey. On arriving at Paint Hills and Cape Hope, as extended an examination of the Huronian rocks as possible will be made, and we will leave in time to arrive at Moose early in September, so as to be able to send out specimens, etc., by the Hudson's Bay Co.'s ship, and also to escape the heavy gales always due in the first half of that month.

Work after opening of navigation.

"If the ice hangs heavily on this coast until July, I do not think it advisable to try to explore the outer islands in our lightly-built craft, and so, instead of waiting longer for it to clear, we will leave early in July for the southward, where the time may be profitably spent on the Huronian areas. These are my intentions at present, but plans

may have to be changed in consequence of various circumstances—for one thing, there may be no dogs, as a large number died last winter and the disease may come again. In this case I will go inland without them as we did on the Hamilton River.

"Before closing I wish to state that Mr. Young and the other members of my party have been most diligent and efficient in the discharge of their duties."

NEW BRUNSWICK.

The following account is given by Mr. Chalmers of his field-work in, New Brunswick, in the later part of the summer :—

"On the 29th of June, I left Ottawa for New Brunswick, to resume the survey and examination of the surface geology of that province, especially of the quarter-sheet map No. 1, N.W., which includes the principal part of York, and smaller portions of Sunbury and Carleton counties. The survey of the area embraced in this sheet was begun in 1893 and continued in 1894, and it was now proposed to complete it. Mr. W. J. Wilson, of the Geological Survey, joined me early in August, and the remaining summer months were spent in this work, namely, in mapping the superficial formations and forest-covered areas, measuring the heights of the hills, lakes, etc., by aneroid or spirit-level, and in studying the different kinds of superficial formations which characterize the district.

Work in New Brunswick by Mr. Chalmers.

"The surface geology of this portion of the province, although affording nothing new, was found nevertheless to possess many interesting details. From the extent of country cleared of forest, better facilities are afforded for examining its surface deposits than in most other parts of the province. The most striking natural feature of western New Brunswick is the valley of the St. John River. This and some of the valleys of the larger tributaries, trench this otherwise plateau-like district in such a manner that, except in the Carboniferous area, few horizontal or base-levelled surfaces are to be seen. Evidences of dislocations and uplifts, with probably correlative subsidences, and in some instances apparent tilting of blocks of the land, within times geologically recent, appear to be found. These changes have in some instances affected the present drainage lines and have obliterated old ones. Numerous facts in regard to subærial denudation, the origin of lake-basins, the transportation and disposition of the materials constituting terraces, kames and other forms in which the thick beds of sand and gravel found here occur, were observed. These terraces and kanes are especially noteworthy on

Valley of St. John River.

the west side of the St. John, though the valleys of the Keswick and Nackawicac on the east side, exhibit thick beds of modified gravel and sand much denuded. Well developed terraces in the tidal part of the St. John, show former water-lines considerably higher than the river-floods of the present day reach; but whether these are of fresh water or marine origin has not yet been fully determined.

Lakes.

" Many beautiful lakes are found scattered over the areas of pre-Carboniferous and granite rocks in western New Brunswick, that diversify the scenery and give a pleasing effect to the landscape. Usually the larger lakes occur in groups, as, for example, the Cheputnecticook, Eel and Magaguadavic lakes. The basins of several former lakes were also found, notably at Brockaway settlement in the Magaguadavic valley, at Canterbury station and in other places.

The Grand Falls.

" As much interest attaches to the Grand Falls of the St. John, and as some uncertainty exists in regard to the measurements of the height above sea-level formerly made, it was thought advisable, when we were in the vicinity, to connect the upper and lower basins, so-called, with the height of the Canadian Pacific Railway station there by a series of levellings. Two or three days were spent in this work, and from the measurements effected, the upper basin was found to be 417 feet above mean tide-level, and the lower basin 300 feet, according to the September height of the river, the season of the year when it is generally lowest.

Height of river above the falls.

" In the North-east Boundary Survey, under the direction of Major J. D. Graham, one of the United States commissioners, to whom was assigned the survey of the line from Passamaquoddy Bay to the highlands that divide the waters which flow into the Atlantic Ocean from those flowing into the St. Lawrence, 'a line of levels, with two spirit-levels checking each other, was carried from mean tide at Calais, Maine, to the monument at the source of the St. Croix River. Thence it was run along the true meridian to the intersection with the River St. John, the surface of which at this point was found to be 419·2 feet above the level of mean tide at Calais. The basin of the river immediately above the Grand Falls may be stated as of the same height, in round numbers, (although two miles and a-half further down stream) as there is very little current between these two points.'

" It thus appears that the elevation of the upper basin of the Grand Falls, as based on the Canadian Pacific Railway levels, is very nearly the same as that obtained by Major Graham, the difference not being greater than may be due to the seasonal fluctuations of the river's level·

"The British Commissioners on the North-east Boundary Survey, Messrs. Featherstonhaugh and Mudge, from an elaborate series of barometric levellings based on the tidal portion of the St. John River, arrived at different results, finding the height of the upper basin of the Grand Falls to be only 296·75 feet above the sea. And from this point as a base, Mr. Wightman measured the altitudes of a number of mountains and lakes between the Upper St. John and the Baie des Chaleurs with the barometer. A list of these is given in Hind's Preliminary Report,* but it is believed they are all too low.

"In seeking base-levels from which to measure altitudes with our aneroids, we had sometimes to make use of the tidal portion of the St. John River between Indiantown and the head of the tide above Fredericton, and the actual height of its surface with reference to high-tide or mean-tide in the Bay of Fundy, therefore, became an important question. Attempts were made to ascertain this by levelling from the Canadian Pacific Railway to certain points; but the results thus far obtained are incomplete owing to causes unnecessary to detail. Nevertheless, they serve to show that the level of this portion of the river is remarkably inconstant, rising and falling with the non-tidal portion above tide-head, and that it is but little affected by the tides. At the lowest stages of the river in autumn and mid-winter, there seems to be a hydrographic depression there at high-tides in the Bay of Fundy, the surface being then below that level. Owing to the narrowness of the St. John at the falls near the mouth, only a limited quantity of sea water can flow in at high-tides; consequently the interior basin, or depression referred to, is raised only a few inches (about sixteen inches at Indiantown and five at Fredericton†) before the ebb sets in. But the reason why this portion of the river falls below the level of high-tides seems to lie mainly in the fact that there is a greater outflow than inflow at these tidal falls. For example, the flow inward commences about two hours and a-half before high-tides, and continues two hours and a-half after. The time for vessels to go through the falls is given in the almanacs as follows:—'The falls are level, or it is still water at about three hours and a-half on the flood, and at about two and a-half on the ebb. Much depends on the floods in the St. John River, and the time of high-water, or full sea, which is often hastened by high southerly winds.' ‡Between every two successive high-tides, therefore, the flow outwards lasts fully seven hours, while

Search for datum points.

Tidal slopes on St. John River.

*A Preliminary Report on the Geology of New Brunswick, etc. By H. Y. Hind, M.A., 1865, pp. 22-32.

†Tidal Phenomena of the St. John River. Bull. Nat. Hist. Soc. of N.B. No. XV, 1897. Prof. A. Wilmer Duff, M.A.

‡I am indebted to Mr. S. W. Kain, of St. John, for information on this question.

the inflow continues only about five hours. At neap-tides the inflow is still less and the outflow correspondingly greater. This discharge from the tidal basin of the St. John, unless compensated by an equal or greater inflow from the non-tidal part above, brings about a general lowering, during the seasons mentioned, to a level below that of high-tides in the Bay of Fundy. The height and attitude of the water-surface in this portion of the river, it thus appears, are dependent upon several interrelated and complex conditions. Generally speaking, it may be stated that it oscillates between the high-tide and mean-tide levels of the Bay of Fundy. At the railway bridge, Fredericton, the autumn level of the St. John at high-tide was found to be one foot nine inches (1·77 ft.) lower than that of the same tide in St. John Harbour, the distance between these two points being eighty-five miles. At Westfield Beach, twelve miles from St. John, it was found to be approximately six feet and a-half (6·60 feet) lower. These figures are subject to correction, the levels used being those of the Canadian Pacific Railway. They indicate, however, a gentle incline in the surface of the St. John at and below Fredericton, but how far down river has not been ascertained.

Complex relations.

Character of surface of country.

"The agricultural condition of the country is of much interest and a number of excellent farming tracts are included within the limits of the map-sheet referred to. The valley of the St. John is especially noteworthy in this regard, a considerable width of alluvial soil being found on each side of the river. Good tracts of arable uplands were also noted in York and Carleton counties, and many of the farmers are in prosperous circumstances. A large extent of the country embraced in this sheet is still forest-clad, though portions of it have been swept by conflagrations. Lumbering is, however, still an important industry, and wherever these fires have not destroyed the woods entirely, the younger or second growth of trees is rapidly taking the place of those cut away in the ordinary lumbering operations. It is observed, however, that the spruce logs are becoming somewhat smaller than formerly; but the conservative regulations adopted by the provincial government relative thereto, will, doubtless, afford such protection to the younger forest growth as to ensure its yield for commercial purposes for generations to come.

Discovery of Silurian fossils.

"Before closing work for the season, Mr. Wilson, while engaged in mapping some forest areas and surface deposits along the St. Andrews and Woodstock branch of the Canadian Pacific Railway, was fortunate enough to discover fossils about six miles from Canterbury station, in the belt of rocks lying north-west of the granite area in western York. I thought it best while we were in the vicinity to make a

collection, and accordingly a few days were spent in doing so. The fossils when submitted to Dr. H. M. Ami, were pronounced by him to be Silurian, though the rocks in which they occur have hitherto been classified as Cambro-Silurian.

"The rocks in which the fossils were found consist of partially altered, gray slates, with certain shaly bands, and dip N. 20° W. 80°. A wide belt of somewhat similar strata, closely conformable, and in nearly vertical attitude, is exposed in cuttings along the railway-track here. About half a mile south-east of the fossil bed a reverse dip comes in, and dark pyritous, highly altered bands are interstratified with the gray slaty rocks. No fossils were detected in these.

Distortion of fossils.

"The fossils seem to have been subjected to great stresses, many of them being flattened and stretched out or otherwise distorted in a remarkable manner, showing the effects of the pressure more than the rocks containing them do. It was observed, however, that the slaty cleavage and bedding approximately coincide, and the question arose whether it is not to this fact that the extremely distorted condition of the fossils is due—that is, to the fact that the shearing and lines of flow have been always at right angles to each other. Further investigation is, however, required to elucidate this question.

"Following is a preliminary list of the fossils as determined by Dr. Ami:—

Forms determined.

"Crinoidal columns and fragments belonging to at least two distinct species. *Orthis* (*Rhipidomella*), sp., compare *Rhipidomella oblata*, Hall from the Lower Helderberg of New York State and Canada. *Orthis*, sp. indt. smaller than preceding but with coarser and less numerous costæ. *Leptæna rhomboidalis*, Wilckens, *Strophomena* or *Streptorhynchus*, species undetermined. *Spirifer*, sp., two distinct forms at least present. *Pterinea textilis*, var., an example showing characteristic sculpture of this uppermost Silurian species.

"The season's work closed on the 25th of October.

"In the New Brunswick work Mr. Wilson gave me important and valuable assistance, some portions of it having been carried on independently by him."

Work by Prof. L. W. Bailey.

Professor L. W. Bailey was again employed in field-work in New Brunswick. Some of the observations made have been incorporated in his report on the mineral resources of the province, shortly to be issued, other data obtained will be reserved for a later report on cer-

tain features in the geology of New Brunswick. The following is Professor Bailey's account of his operations during the summer :—

"According to your instructions received in June last, these investigations were mainly directed to two objects, viz. : (1) the obtaining of any additional data which might be available, bearing upon the question of the mineral resources of the province, and, (2) the more definite determination, if possible, of the age and relations of the great bands of slaty rocks that traverse the central portions of New Brunswick on either side of the central granite belt.

Further investigation of minerals.

"(1.) The information of an economic character thus obtained, being supplementary to that collected in the previous year, a report upon which has already been submitted, it has been thought well to take advantage of a delay in the printing of the latter to incorporate therein all additional matter available, as has now been done. This matter relates more particularly to the gypsum deposits of Albert county, various quarries of building-stone, the Albert shales, clays for brick-making, sands, mineral paints, etc. The report referred to, as thus amended, is now passing through the press.

New facts relating to coal deposits.

"In connection with this branch of inquiry, considerable attention was devoted to the consideration of the occurrence of coal in New Brunswick, increased interest in this direction having been awakened through the results of borings undertaken at various points. Among these that of Dunsinane, in Kings county, is especially interesting as revealing a thickness of the coal-formation at this point, (over 1300 feet,) which was entirely unsuspected and which makes it possible, at least, that the hitherto accepted view that the coal-formation of New Brunswick is very shallow may be erroneous. As bearing further upon this subject, visits were made to various parts of the Carboniferous area, especially about Moncton, Buctouche, Chatham, Caraquette and the Miramichi River, with a view to obtaining new data for a general discussion of the whole subject. As this discussion was too lengthy for incorporation in the report mentioned above and will be based to some extent upon a critical examination of the cores from borings, not yet available, it is proposed that it shall form a portion of a separate report, in connection with the discussion of the topic next to be referred to.

Examination of slate belt.

"(2.) In the study of the slates and associated rocks of central New Brunswick the discovery of fossils was considered to be of primary importance. Hence a large amount of time was devoted to this object, an amount, unfortunately, quite out of proportion to the results. In particular, it was hoped that something might be obtained by a systematic search along those portions of the North-west and South-

west Miramichi rivers and of the Nashwaak River that are bordered by these rocks ; but on reaching these streams at the points to be studied, the extremely low state of the water was found to be such as to make their navigation wholly impracticable. Resort was then had to the St. John River and its numerous minor tributaries in York and Carleton counties, the fossiliferous beds of the Beccaguimic River being first examined, and a study then made of the fine section, exclusive of the granite almost continuous for forty miles, between the last-named stream and Fredericton. No remains of distinctly organic origin were found ; but the discovery on the main river, above the mouth of the Shesgomoc Stream, of calcareous strata, which, though metamorphosed and non-fossiliferous, cannot well be other than the equivalents of the fossil-bearing limestones of the Beccaguimic, will serve to make much clearer the geology of this part of the province and to give a wider basis for the discussion of the age of its contained formations.

"The discussion in question will form a second division of the next report, and will include the results of the study of the Beccaguimic fossils, already forwarded to the office of the survey.

Further details to be given.

"The time devoted to the above work was three months."

NOVA SCOTIA.

Mr. H. Fletcher was engaged during the winter of 1897-98 in plotting the surveys made in Cumberland county referred to in the Summary Report for 1897, (pp. 99 to 100,) and in revising those made by his assistant, Mr. M. H. McLeod, in connection with the preparation of several sheets of the geological map of Nova Scotia. He also made sections based upon a re-examination of the upper portion of Logan's section from Shulie to Two Rivers for comparison with the rocks of the south side of the basin.

Work by Mr. H. Fletcher.

On the 16th of June, he left Ottawa for field-work in Nova Scotia, and did not return to Ottawa until January 8th, 1899. On this work he reports as follows :—

"I was again assisted by Mr. McLeod, who was detailed to make the surveys necessary to complete map-sheets 59 and 60. The rocks examined by him are chiefly those which overlie the Coal Measures, and would thus, according to Dr. Selwyn's classification of 1881, be called Permian or Upper Carboniferous. They have been mapped as Permo-Carboniferous by Dr. Ells, who has included with them most of the rocks at one time called Triassic in Prince Edward Island. They are spread out in a syncline, the axis of which extends almost due west from the mouth of French River, and which has been already

Field-work by Mr. McLeod.

described as crossing Tatamagouche River and River John. From Malagash Point an anticline, running parallel, brings rocks of the Carboniferous limestone series from beneath the former—both series resting unconformably upon the igneous and metamorphic rocks of the New Annan and Baxter mountains, Tatamagouche Mountain and other portions of the Cobequid Hills, the contact being in places complicated by faults.

Springhill coal-field.

" My own work was confined principally to the district adjacent to the Springhill coal-field, and to a closer study of the faults and folds affecting the Coal Measures there, in which I was again efficiently assisted by Mr. G. W. McCarthy, who was with me by the kind permission of Mr. J. R. Cowans, and traced, by means of bore-holes and trial-pits, the lowest seams worked at Springhill mines to a distance of more than two miles and a-half beyond the point to which they were proved by the late Mr. Scott Barlow and Mr. John Anderson.* I have also to thank Messrs. George Hall, Ben. Parsons, John Murray, C. Hargreaves, Arthur Alloway, Harvey Howard, William Conway, and other officials of the Cumberland Railway and Coal Company, and the owners of the land on which this work was done, among others, Messrs. Wesley Herrit, Fred Jones, Alfred Smith, Rufus and Levi Gilroy, Thomas Boss and Mrs. Stephen Herrit.

" The details are not of such a nature that they can at once be presented, but the general results may be briefly stated.

" So much has been already written about the Springhill coal-field, that reference need be made only to modifications resulting from an extension of the underground workings and the proving of the outcrops of the coal-seams to the south-eastward.

Seams worked.

" The three seams at present mined at Springhill are called, in descending order, the North Slope or Thirteen Foot seam of Barlow's reports† the East Slope seam and the West Slope, Eleven-foot or Black seam. The workings of the Syndicate or South Slope are on the North seam,‡ those of the Aberdeen or No. 5 Slope, on the West seam. The North Slope has been sunk past the 3200-foot level, without diminution, I am informed, in the size and quality of the coal, while the 1900-foot level has been extended to a point about seven chains across the Athol road, thirty-nine chains west of Miller's corner, far beyond the fault once supposed to determine the western boundary of the coal-field, which may indicate that the overlap of the upper rocks is here upon the Productive Measures rather than upon

*Reports of Progress, Geol. Surv. Can., 1873-74 p. 156 and 1875-76 p. 346.

†Report of Progress, Geol. Surv. Can., 1873-74, p. 154.

‡Trans. Can. Soc. of Civil Engineers, vol. II., p. 404.

the Millstone Grit. The continuation of this slope, a line of surface-pits in that direction, or the tracing of some of the uppermost seams will solve this doubt.

"The great fault running south from Stewart meadow, with which this is connected on the map of 1885, seems not to pass the railway from 'the Lower Carboniferous outlier,' but instead to turn nearly at right angles to the eastward towards Saltsprings and perhaps to join the Black River fault. The fault, stated by Dr. Ells, on the authority of a former manager, to terminate the coals against the limestone, was subsequently shown to be of minor importance, by the connection of the underground workings on the West Slope seam with those of the Aberdeen Slope, which were continued far past it; the coal at the face being still, it is said, seven feet thick and of good quality. The extension of the lower levels in this direction is likely to prove this corner of the field, while a tunnel, now being driven across the strata from the West Slope seam, will test the underlying seams, some of which have been to a small extent worked. Faults.

"The 2600-foot level, already driven 2700 feet south-westward from the North Slope, follows a small fault or roll, which is perhaps a prolongation of that which skirts Coalmine Brook for a quarter of a mile the present crossing of the railway to Parrsborough.*

"About fifty feet to the eastward of the last pit mentioned by Mr. Barlow, on the West Slope seam,† another was sunk eighteen feet, to the seam, which below that point showed the following section:— Seams traced.

	Ft.	In.
Top coal	2	2
Shaly coal and black shale	0	6
Coal	0	9
Shale	0	1
Coal, in part soft and shaly	2	10
Stone, mixed with coal	1	0
Under water and not well seen	3	0
	10	4

"It does not appear that either the top or bottom was exposed in this pit. From it the coal was closely traced to the Herrit road, on the east side of which a bore-hole passed through fourteen feet and a-half of coal and shale; while, about three chains to the southward, a seam was found in the proper relative position for the East Slope seam.

* Annual Report, Geol. Surv. Can., vol. I (N.S.), p. 31, line 24.

† Report of Progress, Geol. Surv. Can., 1875-76, p. 346.

Jones Brook. "On Jones Brook, about a quarter of a mile further east, these two seams were again found the uppermost containing about eight feet three inches of excellent coal, with two partings of shale each about three inches thick, while the coal in the thick lower seam appears to have improved.

Hill's pits. "Half a mile east of the Herrit road, pits were sunk in 1865 by an American company, which is stated to have expended $20,000 in testing their claims and to have succeeded in proving at least two workable seams of coal of good thickness. These belong also to the Springhill series, as inferred by Messrs. Woodhouse and Jeffcock in their report, and are no doubt identical with the above. Both were bored through by us, and a considerable thickness of strata was also tested both above and below, after which the lowermost seam was traced to the eastward, and proved to be that opened at McCarthy's slope, near the point at which (Report for 1873-74, page 159) two seams were said to have been found by Mr. Probert. The uppermost seam was not, however, opened by us hereabout. A gray, massive sandstone, containing concretions of coherent, calcareous, brown-weathering, ringing, fine sandstone, that lies between the two seams, appears in blocks associated with drift coal at a large spring a quarter of a mile east of McCarthy's slope, or more than a mile from the Herrit road, indicating no doubt the proximity of the coal, which was not, however, tested.

McCarthy's slope.

Smith Brook. "An outcrop of this sandstone, about half a mile further to the eastward, led to the discovery of coal on the north side of Smith Brook, where the upper part of the lower seam was pierced in a bore-hole as follows:—

	Ft.	In.
Surface	8	0
Gray sandy shale	3	0
Gray argillaceous shale, with harder layers	5	0
Coal with thin partings	3	3
Shale or slaty coal	0	3
Good coal	1	8
Shale	0	2
Good coal	1	5
Gray shale	0	4
Good coal	3	1
Greenish coherent underclay		
	26	2

"In an adjoining hill the pavement of an overlying seam was exposed, which may represent the East Slope seam, but was not tested.

"The next openings lie nearly half a mile to the south-eastward, along the north bank of Sugarwood Brook, a tributary of the South Branch of Black River. Here the first bore-hole passed through about eighteen feet of coal, with several thin partings of shale, while further down the brook the following section was cut through and bored :— Sugarwood Brook sections.

	Ft.	In.
Gray sandy shale	1	8
Coal, with two small partings	1	7
Clay	0	4
Coal and coaly shale	1	1
(This upper portion of the seam does not appear in the borings to the westward.)		
Soft clay	0	4
Bluish-gray argillaceous shale	3	10
Coal	0	7
Dark argillaceous shale with *Stigmaria*	1	0
Coal	0	1
Coaly shale and coal	0	5
Good coal	1	9
Gray shale	0	8
(The above section is exposed in a pit. The following strata were bored through.)		
Coal	1	5
Shale	0	11
Coal	3	9
Gray shale	2	1
Coal	2	1
Shale	1	4
Soft coal	2	7
Dark-gray soft underclay	3	0
	30	6

Sections in adjacent pits.

"In the immediate vicinity of the foregoing sections, a great difference is found in the strata overlying the top coal. In three adjacent pits, only a few feet apart, the section is as follows:

No. 1.

	Ft.	In.
Gray shaly sandstone with concretions.	13	0
Gray conglomerate and coarse grit	6	0
Gray flaggy sandstone	3	2
Gray pea- and nut-conglomerate, containing large pieces of greenish argillaceous shale and fragments of coal	3	0
Broken rock, perhaps conglomerate but doubtful, possibly crushed down over the coal	3	6

No. 2.

Greenish-gray very fine sandstone in thick beds	10	6
Gray or dark argillaceous shale	3	4
Greenish-gray or drab very fine sandstone or arenaceous shale	1	2
Gray and yellowish argillaceous shale	0	9
(The above section is that in the pit. It is continued by boring as follows.)		
Coal	1	6
Shale	0	2
Coal	1	8
Dark shale	1	7
Coal	0	4
Dark shale	0	8
Coal	0	7
Shale	0	3
Coal	0	6
Shale	0	11
Coal	1	7

No. 3.

Gray banded sandstone	2	3
Dark-gray coarse grit and conglomerate	2	3
Gray and dark-gray coherent sandstone with *Calamites*	1	6
Gray pea-conglomerate	2	8
Gray, thick-bedded, striped sandstone full of carbonized plants	3	9
Dark-brownish and gray, coaly, crumbling, fine grit.	1	0
Gray argillaceous shale	0	9
Coal	—	—

"In pit No. 2 the upper part of the coal seam appears to be wanting.

"In a fourth pit the rock was greatly broken and the top of the coal was again wanting. This irregularity and replacement of the finer rocks above the coal, in so short a distance, suggests a possible overlap or unconformity. But where this might have been determined, the coal-seam meets a fault, running south-westerly along Sugarwood Brook, by which it is thrown about 350 feet to the north-eastward. Its crop was again traced about 270 feet, to another small fault, at which the thrust seems to be to the south-westward. At a distance of about 600 feet south-east of the brook the following section was obtained by boring: Section in fourth pit. Section determined by boring.

	Ft.	In.
Sand and clay	4	0
Drift coal, not found to the dip	3	2
Gray argillaceous shale	0	10
Conglomerate	1	10
Gray sandstone of fine grindstone grit	2	10
Dark blackish argillaceous shale	0	5
Light-gray soft argillaceous shale	3	3
Good coal	1	6
Dark shale	0	3
Coal	0	5
Shale	0	3
Coal	0	4
Shale	0	7
Coal. (This may be the top coal of the foregoing section)	0	5
Soft shale	0	8
Gray argillaceous shale	2	5
Coal	0	3
Black shale and coal in thin layers	2	0
Good coal	0	9
Shale	2	8
Good coal	4	6
Shale	0	5
Good coal	1	9
Shale	0	6
Coal and coaly shale	1	7
Shale	0	6
Coal with three one-inch hard bands	2	4
Shale	0	6
Good coal	1	6
Shale	1	3
Coal	3	4
Gray shale, somewhat hard, with a little coal	1	0
	48	0

Sections only approximate.

"These sections, cut by a hand-drill, must be taken as merely approximate and subject to correction, but they serve to show the general structure of the seam. Some good layers of coal were exposed at various points by shallow pits. The season was too wet for sinking a shaft necessary to prove the whole thickness of this seam, and, the ground becoming covered with snow, work had to be discontinued before the seam was found further to the south-east. Had it been possible to prove about 2100 feet south of the above bore-hole, the relation of the thick coal seam to a conglomerate (shown on Mr. Barlow's map of 1874 as running from a point near the fork of the roads at Tom Boss' south-westerly down the Maccan River with a north-westerly dip), might have been made plain. This conglomerate I am at present disposed to regard as above the workable coals.

Coal beneath the west slope seam.

"A bore-hole near the head of Sugarwood Brook, cut a twelve-foot seam of coal and shale in alternate layers, which probably underlies the foregoing; while about 850 feet down-stream from the last opening on the latter, nine feet and a-half of similar alternations, probably overlie; neither seam being workable. In the main South Branch of Black River, half a mile above the bridge at Tom Boss', a small seam of coal with a very low south-westerly dip seems to overlie all the foregoing. All the rocks of this vicinity are nearly horizontal,

Claremont anticline.

"From the above description of the trend of the coals at the Herrit road, it may be inferred that an anticline passes near this point, a prolongation of that of Claremont toward Mapleton. Some work was done where this line crosses the Leamington and Old Mountain roads, but more will be required before the precise relation of Barlow's highest coal-seam, traced by him to the Athol road past the furthest underground levels, to the small coals of Harrison Brook, the Old Mountain road and the deep bore-hole at Mapleton can be defined.

Rocks above and below Coal Measures.

"The rocks overlying and underlying the Coal Measures between Thompson and Westchester, and towards Rodney and Southampton, have also been, to some extent, studied, in an attempt to harmonize the various views held in regard to the different groups of rocks, the similarity of which in mineral composition and fossil contents has led to their being often confounded. Some attention was also paid to tracing the Black River fault,* well seen in the river at Keiver's bridge, about a mile further down stream, and at the mouth of Johnston Brook.

Examinations made with Dr. Ami.

"Two or three days were spent with Dr. Ami at Harrington and Moose rivers, examining the rocks compared with the Devonian of

* Report of Progress, Geol. Surv. Can., 1873-74, p. 168.

New Brunswick by Dr. Ells*, which Dr. Ami, on the evidence of the fossils, now correlates with the Riversdale and Horton series, and calls Carboniferous. It must, however, be remembered, that the Horton has been stated by Sir J. W. Dawson to be equivalent to several groups that by some geologists are regarded as Devonian.

"In the course of last season I visited several places in which mining developments of supposed economic importance had been made. Economic minerals.

"At one of these, in Lowe Brook, about a mile above the pumping station, some two miles from Amherst towards Salem, a seam of coal, six to eight inches thick, in three layers and for the most part good, was uncovered among gray and drab argillaceous shales and sandstones containing fossil fern-fronds two inches long. Coal near Amherst.

"The manganese deposit in the same neighbourhood was again worked last season, and a small quantity of good ore was extracted.† Manganese.

"In November, I examined a portion of the line of the railway now under construction from Windsor to Truro, along which petroleum was reported to have been found. On the part constructed between Windsor and Mosherville, only a few masses of marl, gypsum and limestone were encountered, the cuttings showing chiefly masses of sand, clay and gravel with boulders.

"In October, by your instructions, I went with Mr. C. A. Meissner, manager of the Londonderry iron mines, to Whycocomagh, to note the developments made by him on the iron ore of the brook that flows through the Indian Reserve. The associated rocks of this district are lescribed in the Report for 1882-84, pages 34 H and 91 H. The present workings lie about half a mile above those formerly opened, and the ore may follow the course of the stream, as indicated by a band of quartzite. A tunnel driven into the west bank, high above the stream, cut quartz and quartzite, succeeded by about seven feet of hard red hæmatite and rock in layers of from two to four inches in thickness, after which comes nine feet of ore, partly specular iron and partly hæmatite, with an occasional admixture of fine-grained magnetite. The average of this nine-foot band is said to be fifty per cent of metallic iron. It contains about five-tenths per cent of phosphorus, ten to fourteen per cent of silica, and a variable quantity of sulphur. In the front of the vein a good deal of pyrite was found, while the back part which contains the solid ore has little sulphur. Another tunnel, eighty feet below the first, went through twenty feet of limestone, dark-green slaty rock eighty feet, then ten feet of dark quartzite ; but, at last accounts had not cut the ore. Whycocomagh iron ores.

*Annual Reports Geol. Surv. Can., (N. S.), vol. I., p. 51 E, and vol. V, p. 69 P.
†Summary Report, Geol. Surv. Can., 1897, p. 101.

"Other openings have been made in this mountain which exposed iron ores more or less promising. At the same time a visit was made to the pits, sluices, etc., on the brook at the head of Whycocomagh Bay, where search had been made for gold, and where a tunnel, 130 feet long, had been driven from the brook through the pre-Cambrian rocks. All work had been discontinued before the date of my visit.

Search for gold.

Mines at Cheticamp.

"The Cheticamp Gold Mining Company began active operations on the 28th of April last, on a mixture of sulphides, principally galena in large lenticular masses, in the pre-Cambrian slates of Faribault Brook. A good road has been built from the settlement, nearly three miles distant, to the deposit. Shafts have been begun and a considerable quantity of ore has been extracted. A concentrating plant capable of treating fifty tons of ore a day, a forge, workshop, boarding-house and two or three miners' houses are being erected. At the time of my visit about fifty men were employed, and the company is said to have expended $30,000.

Loch Lomond.

"On January the 4th, 1899, I visited, with Mr. J. A. Gillies, M.P., a deposit of galena and chalcopyrite found to contain silver and gold, in rocks of the same age about a quarter of a mile east of the middle lake at Loch Lomond, in Richmond county. The ore is in a quartz vein four feet and a-half thick, exposed in a pit fourteen feet deep and twelve long, and said to have been cut at some distance both ways from the pit. The vein is of some promise, but too little work has been done to determine its value.

Coal of Cochran Lake.

"A small quantity of good coal was taken by Mr. E. W. Moseley, from a shaft eighteen feet deep to the top of the seam, about 500 feet to the eastward of the pits sunk by his father, the late E. T. Moseley, of Sydney, south of Cochran Lake.* An attempt made to open this seam in the neighbourhood of Loon Lake was frustrated by quicksand found to a depth of twenty-seven feet in the pit."

Work by Mr. E. R. Faribault.

The greater part of last winter's office work was devoted by Mr. E. R. Faribault to the completion of the large scale plans of the gold-mining districts surveyed the previous summer in the county of Guysborough and in the eastern part of the county of Halifax, and described in last year's Summary Report. Ten of these plans were prepared for the engraver and their reproduction attended to. The plans of Goldenville, Salmon River, Moose River and Mooseland were printed on the scale of 250 feet to one inch and those of Oldham, Caribou, Killag, Fifteen-mile Stream, Forest Hill and Upper Seal Harbour on the scale

Plans of gold districts published.

* Summary Report, Geol. Surv. Can., 1897, p. 102[a]

of 500 feet to one inch. Some time was also occupied in the study of the geological structure of these districts, in order to define the richest auriferous zones and the relation of these to the different parts of the anticlinal folds, and to determine their extension beyond the present developments to greater depths.

Some progress was also made in compiling the one-mile to an inch map-sheets of the country lying immediately north-east of Halifax, completing for publication the Shubenacadie sheet (No. 56) and the Lawrencetown sheet (No. 53.) The first black proof of the former sheet has been received from the engraver and corrected, and the latter sheet is now ready to be engraved. The first black proofs of the Eastville sheet (No. 48) and Upper Musquodoboit sheet (No. 49) have also been received and corrected, and the Moose River sheet (No. 50) has been printed. Progress of map-sheets.

Progress was also made in collecting notes to complete the general report on the gold fields of eastern Nova Scotia.

On the work accomplished in the field during the past summer, Mr. Faribault reports as follows :— Field-work in 1898.

"In compliance with your letter of instructions, I left Ottawa on the 11th of June to complete the mapping and study of the structural geology of the gold-bearing belt lying to the east of Halifax, in order to prepare for publication the map-sheets covering that area, and to make special plans of the principal gold districts not already surveyed in that region.

"I was again assisted in the field, during the season, by Messrs. A. Cameron and J. McG. Cruickshank, who have been my assistants continuously since 1885 and 1887, respectively. I have to thank many gentlemen for information, assistance and hospitality, and I wish to mention especially Messrs. Edwin Gilpin, Inspector of Mines, and T. R. Gue of Halifax, A. A. Hayward and D. C. Wilson of Waverley, G. J. Partington and John H. Anderson of Musquodoboit Harbour, and J. H. Townsend and John Murphy of Tangier. Assistants.

"Doubtful points to the east and north of Halifax, have been re-examined and some of the anticlinal folds and boundaries of the black slate belts have been located with more accuracy, in order to determine the most important faults. Re-examination of country east and north of Halifax.

"The Montague anticline was traced westward to Brady's farm on the Waverley road, to the west of which it is cut by an important fault running north through the Waverley chain of lakes. The fault has shoved the Montague anticline 7000 feet to the north, two-thirds of the way up the west side of Lake Charles, where it was located and

traced westward about Taylor's Lake and to Navy Island in Bedford Basin, where it appears to form a broad dome with an east and a west pitch, characteristic of a gold-district. Rich float quartz was discovered last year along this anticline in the cuttings of the Dartmouth Railway Branch, north of Burnside, and a large block of areas has been taken up under lease or prospecting licenses.

Gold at Burnside on dome of Montague anticline.

Faults.

"An important fault has been located at the head of Porters Lake, and traced north-east through Dollar Lake; and another parallel fault was determined one mile south-east of Oldham and traced to Soldier Lake.

Auriferous veins at Karney Lake.

"An anticlinal fold runs N. 28° W. (*mag.*) along the middle of Karney Lake and forms a broad elliptical dome extending north from the outlet of the lake to the Hammond Plains road. Several corrugated interbedded veins have been observed along this belt and gold is reported to have been found on the east side of the lake.

Auriferous veins on domes of the Horne settlement anticline.

"A dome with all the characteristics of a gold district was also located on the Horne settlement anticline, crossing the middle of Shubenacadie Grand Lake. The eastern end of the dome crosses the south-east shore of the lake half a mile north of the outlet, where a belt of auriferous veins has been prospected on the north dip. Further investigations should be made here, south of the old works and nearer the anticline. The west end of this dome skirts the north-west shore of the lake as far west as Rocky Brook, where auriferous drift is reported to have been found up the Rocky and King's Meadow brooks; thence it was traced along Sandy Lake and as far west as Joe. Shannaman's farm on the Beaver Bank road. No exposure was found at Indian Point on the Shubenacadie Grand Lake, but the centre of the dome certainly comes near this point, which should be a good field for prospecting. Another dome was located further west on this anticline, along the south shore of Pockwock Lake where quartz was observed at several places. The rocks are greatly altered here by the eastern end of the main granite area forming the backbone of the western part of the province, and only a few exposures of rock could be observed, not sufficient to make out the structure of the dome.

Gold-districts surveyed.

"Special detailed surveys were made, and plans partly completed, of the gold-districts of Waverley, Montague, Lawrencetown, Lake Catcha, Tangier and Cow Bay in the county of Halifax.

Waverley gold-district.

"*Waverley Gold District.*—Three weeks were spent surveying this interesting and important district and a plan on the scale of 250 feet to one inch was plotted in the field. The auriferous quartz veins, which have been worked from time to time since the first discovery of

gold in 1861, are all interbedded between layers of 'whin' and slate on the crown of a huge anticlinal fold. The general course of the fold is N. 80° E. (*mag.*),* and its axis pitches westward at an angle varying from 10° to 35° from the horizon, while one leg dips south, angle 25°, and the other north, angle 70°. Extensive denudation has worn away and truncated this enormous fold to a depth of over 12,000 feet, exposing a horizontal section of strata and intercalated auriferous veins which were formed 7000 feet below the base of the black slate group. The veins conforming with the strata, their outcrops have also a semi-elliptical shape, pointing westward and dipping north, west and south, like the saddle of the fold.

Faults.

"The fault referred to above as following the Waverley chain of lakes, has greatly disturbed this anticlinal fold. The main dislocation runs up Lake William and Lake Thomas and passes immediately west of the short run uniting these two lakes. It causes a horizontal displacement of some 800 feet to the south on the east side of the fault. The west fault runs up by the railway station and through Muddy Pond, and has been ascertained by Mr. A. A. Hayward, in the underground developments of the Lake View Mine, to give a shove of 118 feet to the south on the east side, and to dip east at an angle of 40°. Another line of disturbance was also located by surface trenching on the same property at the south-west cove of Lake Thomas, but the displacement does not appear to be extensive.

Pay-zone 600 feet wide.

"The high dip of the north side of the fold being more favourable to the formation of large and permanent auriferous veins than the low dip of the south side, all the most valuable veins are found on that side. As far as present operations indicate, the pay-zone attains its maximum development immediately north of the anticline on the West Waverley and Lake View properties, where it is over 600 feet wide, and has been worked for a length of 7000 feet. Several leads have been operated along this pay-zone, to depths varying between 200 and 350 feet, on the above properties, and most of them have given good returns to that depth, while a few, especially the most northerly, were found to decrease in size and value. A shaft sunk 628 feet on the dip of the Dominion lead, showed the vein to decrease from fifteen inches on the surface to a mere film of quartz with small lenticular pockets at the depth of 500 feet. A close study of the structure of the anticlinal fold shows that this diminution of the veins in size and value in depth is attained when the northern limit of the pay-zone is reached. In this district, the axis-plane of the fold forms the southern

Workable portions of veins limited to the pay-zone.

Axis-plane forms the southern limit of the pay-zone.

* The magnetic variation in this part of Nova Scotia is about 21° 30′ E.

limit of the pay-zone and it dips south at an angle of 69° from the horizon, while the interbedded veins dip to the north at an angle averaging 70°, giving a diverging angle of 41° between the two planes; so that a cross-cut driven south from the bottom of the 628-foot shaft on the Dominion lead would reach the anticlinal axis at some 650 feet and should develop a large belt of veins in the auriferous zone, many of which do not crop at the surface. A cross-tunnel driven south from the 360-foot shaft on No. 6 lead, on the Lake View property, would likewise develop a belt of auriferous veins in the richest part of the pay-zone. On the West Waverley property, at the depth of 225 feet, a cross-tunnel was driven south 641 feet from the Brody lead to the anticline, cutting ten leads, two of which do not crop at the present surface.

Developments.

"A considerable length of this auriferous-zone is still undeveloped, between the Lake View mine and the Laidlaw Hill property at the east end of the district, the disturbed condition of the strata having hindered, to some degree, any important operations.

Rich "Barrel-quartz" vein worked on anticlinal dome.

"A valuable and interesting 'barrel-quartz' vein, was worked extensively some years ago around the crown of the anticlinal dome on Laidlaw Hill. It was operated as deep as could possibly be expected from individual effort and gave very good returns. A company has lately consolidated these small properties, has driven a tunnel 670 feet long from the level of Lake Charles, cutting the barrel-quartz vein at the apex of the saddle, along which levels have been driven around the dome, 434 feet on its north dip and 238 feet on its south dip. The present developments prove the auriferous value of the vein to that level and for some distance lower, and show that the pay-zone at the extreme east end of the district is confined to the arch-core of the fold, upon which other auriferous veins certainly occur to much greater depth.

Arch-core of fold should be developed.

Yield.

"The total yield of the Waverley gold-district, taken from Dr. Gilpin's report on the 'Ores of Nova Scotia' published this year by the Department of Mines of the province, is, up to date, 61,308 ounces, from 122,346 tons of quartz, valued at $1,200,000, or an average of $9.81 per ton.

Montague gold-district.

"*Montague Gold District.*—Two weeks were spent in a survey of this important district, and a plan on the scale of 250 feet to an inch was partly completed in the field. All the veins operated in the district follow the stratification in the same manner as at Waverley, and are situated along an anticlinal fold that runs N. 78° E., and pitches east at an angle of 8°, on area 781 of the original block, and to the west at a very low angle, at the north end of area 951 in the same block,

forming a long and narrow elliptical dome. The strata lie at a low angle for some distance on both sides of the saddle, the dip increasing gradually till it meets the perpendicular 1000 feet south of the axis, and reaches 70° at a distance of 1250 feet to the north of it, the axis-plane of the fold dipping north at an angle of about 80°.

Pay-zone 500 feet south of axis.

"As far as present developments indicate, all the more important veins are found on the south dip, where they form, at the middle of the district, a pay-zone about 600 feet wide, the northern limit of which is about 500 feet south of the axis. The plan of the district is not sufficiently completed yet to report conclusively on it. A few words, however, may be said of the important pay-streaks which have been worked so extensively on the Lawson lead to a depth of 313 feet, on the Annand lead 250 feet with a trial-shaft 400 feet deep, on the Twin lead 150 feet, and on the Rose lead to a depth of 270 feet with a shaft 388 feet deep. These rich pay-streaks are situated along an imaginary line running almost parallel with the anticlinal axis and they are characterized by enlargements and enrichments of the veins dipping to the west at low angles. Although there is reason to believe that the limit of the pay-zone has not been reached on the above mentioned leads, at the depths to which they have been worked, it is probable that in some of them the limit of the high-grade ore is near at hand. For the zone of rich streaks appears to be narrow, and as it is parallel with the axis-plane, it dips to the north at an angle of 80°, whereas the dip of the veins is to the south, angle about 80°, so that the two planes would give a diverging angle of 20°, and so limiting the length of the pay-streaks on individual veins. Thus, to keep in the pay-zone it becomes necessary to cross-cut north when the limit of the pay-streaks has been reached, and new veins will in this way be developed which might be barren or wanting on the surface.

Richest pay-streaks limited within a narrow zone.

Developments on the Golden Group and Symonds-Kaye properties.

"The Golden Group Company, has lately acquired the Lawson, DeWolf and Rose properties; the plant and mill have been remodelled to handle with economy large quantities of ore; and, if the developments are carried on in the direction outlined above and the auriferous zone is systematically blocked out, there is every reason to believe that the large returns obtained in former years will again be realized, and a new system will be inaugurated which may do much to solve the problem of deep and permanent gold mining in Nova Scotia.

"Important leads are also being operated on the old Symonds-Kaye property at the south-west end of the district, which is characterized by angular veins intersecting the interstratified veins and giving rise to rich pay-chutes at their junctions. The undeveloped ground on the

northern part of this property and immediately west of the Lawson, is certainly promising and should be prospected.

"A few veins have been opened on the north side of the anticline, but developments have not yet been sufficient to locate the pay-zone; the field is, however, promising.

Faults.

"No fault of any importance has disturbed the structure of the fold. One cutting the strata at right angle on the south dip, opposite the middle of the dome, gives a maximum displacement of forty feet, measured horizontally at the Lawson lead, and a few parallel slide-faults have been met with in the workings of the Skerry, Rose and other leads. Their outcrops almost coincide with that of the strata and they dip south at low angles, the top part having moved upward and northward.

Yield.

"The total yield of the district to date is 39,071 ounces, valued at $742,349, from 22,652 tons of quartz, or an average of $32.77 per ton, the highest average of any district in the province.

Lawrencetown gold-district.

"*Lawrencetown Gold District.*—Two weeks were employed surveying this district and a plan on the scale of 500 feet to one inch was partly completed in the field. All the auriferous quartz veins developed some years ago but not worked lately, belong, as in the above two districts, to the interbedded class and are included in an area nearly half a mile wide and over one mile long. The remarkable width of auriferous ground, is due to the presence of two anticlinal folds, converging as they approach this district from the east. The immense strain and pressure accompanying the meeting of these two folds have developed, as at the Moose River district, fissures along the bedding planes which have eventually been filled by segregation, producing the auriferous veins which have been brought to view afterwards by extensive denudation and are now being worked.

Auriferous ground of remarkable width.

Two anticlinal folds.

"The anticlinal folds have a general east-and-west course and are 1800 feet apart at the foot of Echo Lake. The most northerly crosses the lake 1600 feet north of the Mill stream outlet and the other crosses that stream 200 feet below the outlet. The syncline between these two anticlines runs down Echo River to the dam, coalescing towards the west with the southern anticline and terminating on the Shanghai property. All the openings on the east bank of Partridge River are situated on the opposite sides of this syncline, while on the Shanghai property they are on the north limb of the syncline, with the exception of those at the western end of the Bennett lead, which are on the south dip of the southern anticline. The operations along this double fold have established the presence of

a rich pay-zone, which will certainly prove valuable when systematically developed with a proper knowledge of the structure of the strata. As depth is attained on the Wadlow belt, cross-cutting north will have to be done, to keep to the north of the synclinal trough and new veins will then be developed in a promising part of the pay-zone.

Developments of rich narrow pay-zone on Shanghai property.

"Several veins have also been worked for a distance of 2000 feet to the south of the double fold, some of which have given streaks of very high-grade ore; but none of them have been worked to any depth.

"A few small veins have also been tested on the north side of the north anticline, but heavy drift has prevented prospecting along this promising axis.

"One main fault has been located running down Partridge River in a south-east direction to the Lawrencetown Lake, with a horizontal shove to the south of some 200 feet, on the east side of the line; and two other right-hand faults were established to the west, parallel with it, with displacements of about 90 and 17 feet respectively.

Faults.

"*Lake Catcha Gold District.*—Two weeks were devoted to a detailed survey of this district, discovered some twenty years ago, and a plan on the scale of 250 feet to an inch is in progress. All the more important veins operated belong to the interbedded class of fissure-veins and are situated on the north side of a broad anticlinal fold. The general course of the fold is N. 74° E. (*mag.*) It pitches to the east at an angle of 25° and to the west at a low angle, forming a long elliptical dome. The strata on the south side of the axis dip south at a low angle, increasing gradually to 45° at a distance of 500 feet to the south of it. The structure on the south dip does not appears to be favourable for the development of quartz veins. On the north side the dip increases more rapidly and reaches 80° at a distance of 500 feet. In the folding, the strata have been subjected to greater pressure on the north dip, producing fault-fissures along the bedding planes into which important auriferous veins have been segregated. Some of these veins, like the Coleman, Mill and Iron leads, have been traced for a length of over one mile. The greatest depth yet attained in the workings is 225 feet on the Mill lead at the Oxford mine. Rich streaks have, however, been worked on several veins along their outcrops, notably on the Coleman, Mill and Battery leads on the Oxford property, and on the Lake and Sheba leads on the John H. Anderson property. The late J. M. Reid, while in charge of the Oxford mine, kept many records and plans of the underground workings which should prove very valuable in directing further developments. He established three well defined rolls or pay-streaks in the works of the Coleman lead, lying under one another in undulations dipping at

Lake Catcha gold-district.

Extent of veins.

Pay-streaks.

low angles in the plane of the vein. Some of these have not yet been worked out and it would be desirable to sink deeper to find out if other rolls exist beneath.

Zone of pay-ground.

"In looking over the plan of the district, we find that most of the best streaks on the Coleman, Mill, Battery, Lake and Sheba leads are situated along a well-defined zone. This zone leaves the anticlinal axis at the west end of the district, where rich drift has been discovered north-west of the Petite Mare bridge, on the Cogswell areas, and from there it runs N. 60° E. It therefore intersects the veins at an angle of 14°, until at the east end of the district it is found 1400 feet to the north of the axis. Much good ground is still undeveloped on the surface along this zone, on the Oxford, Anderson and Cogswell properties. In pushing the development work to greater depth, the dip of the pay-zone must be taken into consideration. The axis-plane of the fold dips to the south at an angle of 75°, and it is most probable that the pay-zone has the same dip to the south, so that cross-cutting south has to be done in this district, as depth is attained.

Direction of developments.

Auriferous fissure-veins.

"Two interesting auriferous fissure-veins are being developed in the district; one, the Cooper vein, occurs 3000 feet north of the anticline at the north-west end of the district and cuts the stratification in a north-east direction in the manner of an 'angular,' following a layer of slate for a short distance eastward, then cuts across a certain thickness of strata to another layer of slate which it follows to leave it again, and so on. It varies much in size, reaching four feet in places, and appears to show gold and sulphides more freely along certain belts of slate. The other fissure-vein, the Cogswell 'angular,' also cuts the stratification in a north-east direction, at the east end of the pay-zone, and it is more auriferous at its intersections with interbedded veins.

Faults.

"Several faults cut across the stratification and produce important displacements of the veins, often interfering with the progress of operations, but most of them have been accurately established by skilful developments. The most important is a right-hand fault on the Anderson property, running north-west and dipping south-west at an angle of 20°. The others are all high-angle breaks under forty feet, the eastern ones being left-hand breaks and the western ones right-hand breaks. However, there appears to be another prominent right-hand fault at the west end of the district, following La Petite Mare brook, the course of which is about N. 25°E., not yet exactly established, but important on account of the rich drift found on the undeveloped areas lying to the west of it. Total yield to October 1898 is 23,153 oz. of gold from 21,140 tons of quartz.

"*Tangier Gold District.*—Eighteen days were devoted to a survey of this district, one of the first discovered and most important in the province, and a plan on the scale of 200 feet to an inch is in course of preparation. All the veins operated belong to the interbedded class of fissure veins, and occur along the axis of the anticlinal fold furthest south on the Atlantic coast. This fold is the western prolongation of that passing through the gold districts of Harrigan Cove, Moosehead and Ecum Secum; it has a general east-and-west (*mag.*) course, forms a long narrow elliptical dome and pitches to the east and west at angles under 15°. It dips to the north and south at angles reaching 70° on both sides, giving a perpendicular dip to the axis-plane.

Tangier gold-district.

"Auriferous veins have been developed extensively for a length of over two miles along this fold, the most important operations being confined to the veins on the south dip, along a narrow and well-defined pay-zone. This pay-zone touches the anticlinal axis at the centre of the dome, a couple of areas east of the original Free-claim area, where it has a width of some 200 feet, comprising the rich pay-streaks worked on the Big-south, Little-south, and Nugget leads to depths of 100 to 150 feet. From the centre of the dome the pay-zone runs east and west, keeping a few degrees to the south of the course of the anticlinal axis, and intersects the various leads at a slight angle, creating enlargements and enrichments on the veins which have successively been worked towards the west on the Nigger, Butler, Blue, Leary, Lake, Tennant, Field and Bingay leads, and towards the east on the Little-south, Nugget or Kent, Twin or Dunbrack, Forrest and Wallace leads.

Pay-zone well defined, but narrow.

"A few of these leads have been worked along their outcrops for nearly half a mile, but the greatest depths attained so far, are, only 240 feet on the Forrest, 160 feet on the Nugget and Leary, 140 feet on the Big-south, and 130 feet on the Little-south and Field leads. Most of these veins can certainly be successfully worked to greater depths. Still the pay-zone does not appear to have a great width, being only 200 feet wide at the centre and not much wider to the east and west, and, as its dip is about vertical and the veins dip between 55° and 65° to the south, the southern limit of the pay-ground will be reached at no great depth, especially on the southerly veins. Cross-cutting north will then have to be done to keep in the pay-zone, and new veins will thus be developed at their richest parts to great depths.

Developments should follow the pay-zone.

"Most of the district was formerly held in small areas and operated by private individuals with limited means, but it has recently been consolidated under the management of one company, and we may look

Cross-cutting to the north.

now for larger and more permanent operations. The attention of this company might be directed to the desirability of making developments by cross-cutting north from the deeper shafts on the Big-south, Little-south and Nugget leads in the vicinity of the Free-claim area. Likewise, cross-cutting north should be done from the deeper shafts on the Forrest lead on Strawberry Hill property. The Free-claim area may be mentioned as one of the most promising locations for a deep vertical shaft with a system of cross-cuts and levels, as it would develop veins which do not crop to the surface, in one of the richest part of the pay-zone.

Vertical shaft on Free-claim area.

"Very rich drift found south of the Essex mill has not yet been traced to its source. It should be looked for along the pay-zone to the north of the Dunbrack lead.

"Only a few veins have so far been opened on the north dip, and none to any extent, but those immediately north of the axis at the centre of the dome, near the Free-claim area, are certainly very promising.

Faults.

"The structure of the anticlinal fold of this district has been more disturbed than that of any other in the province, by two important series of small faults which have a general north-west and south-east direction, and all dip at high angles. The eastern dislocation occurs on Strawberry Hill and is composed of a series of right-hand faults with horizontal shoves ranging from 76 feet down to a few feet, giving a total displacement of some 280 feet. The extensive operations made on the Forrest lead, have determined exactly the horizontal thrusts of every one of these breaks; but many rich pay-chutes, dipping west at angles of about 45°, have been lost by these faults and might yet be recovered by determining the extent of the upthrows.

"The western dislocation is composed of a series of left-hand faults beginning at the Essex mill, with horizontal displacements along a north-west and south-east course varying from a few feet up to 150 feet, and giving a total displacement of 470 feet. All these faults have been exactly determined by the important surface developments made by John Murphy and the late A. M. Barton, in their endeavour to locate leads to the west of the Essex mill, the drift of which was found very rich along the main road. The block of strata comprised between these two main dislocations has been thrust to the north by lateral pressure and contains the above mentioned promising veins not yet developed, which should be looked for along the pay-zone passing north of the Dunbrack lead.

Diorite dyke.

"A dyke of diorite, 40 feet wide, the only one known in the gold districts of the province, cuts the strata and auriferous veins at right

angles on Strawberry Hill and has been traced in a straight line for two miles to Grum Point on the sea-shore. The dyke does not affect the richness or size of the veins and does not appear to be auriferous. It has, however, altered the adjacent rock for a short distance on each side of it.

Yield.

"The total returns of the district, including the Mooseland mines situated on the next anticline to the north, are, up to date 20,491 ounces, valued at $721,183, from 43,092 tons of quartz.

Cow Bay gold-district.

"*Cow Bay Gold District.*—A hurried survey of this district has been made, but the plan is not yet plotted.

Fissure veins.

"All the veins developed here are true fissure-veins running north-and-south and cutting the stratification at right angles with a vertical dip. A great number of them have already been opened, for a width of nearly four miles across the point of land stretching between the Eastern Passage of Halifax Harbour and Cole Harbour, and a few have been traced for over one thousand feet along their course, but none have yet been worked to any extent. The present developments prove that all these fissure-veins are more auriferous along a certain part of their course, corresponding with the crossing of a highly mineralized belt of gray felspathic quartzite about 100 feet wide, situated at the contact of the upper-slate group with the underlying whin group. Some layers are so heavily charged with specks of magnetic pyrites as to affect the needle of the compass. The strata of this mineralized belt dip to the south at an angle of 35° from the horizon, and the pay-chutes of the veins will necessarily dip to the south at the same low angle and ought to be developed on that incline to great depth. No doubt many of the failures met with in the present operations are due to the ignorance of this important fact."

Richness of veins affected by adjacent rocks.

CHEMISTRY AND MINERALOGY.

Chemistry and mineralogy.

Reporting on the work done in these branches of the Survey's operations, Dr. Hoffmann says:—"The work carried out in the chemical laboratory during the past year has been, as heretofore, almost exclusively confined to the examination and analysis of such minerals, ores, etc., as were deemed likely to prove of economic value and importance. It embraced:—

Analyses and assays.

"1. Analyses of fuels—including lignite, lignitic coal, and coal.

"2. Analyses of natural waters—with the object of ascertaining their suitability for domestic or manufacturing purposes, or probable value as remedial agents—from various localities in the provinces of Quebec, Ontario and British Columbia, as also in the North-west Territory.

Analyses and assays.

"3. Analyses of limestones and dolomites—in continuation of the series of analyses of such stones already carried out, in connection with an inquiry into their individual merits for structural purposes, for the manufacture of lime, or of hydraulic cement, or for metallurgical and other uses.

"4. Analyses of iron ores, including magnetites and hæmatites, from certain localities in the provinces of Quebec and Nova Scotia.

"5. Analyses, in regard to nickel content, of certain ores from the provinces of Quebec, Ontario and British Columbia.

"6. Analyses of rocks from certain localities in the provinces of Quebec, Ontario and British Columbia.

"7. Analyses of several highly interesting minerals, some of which were not previously known to occur in Canada—amongst them, polycrase, a hydrous niobate and titanate of yttrium, erbium, cerium, and uranium; and others which, from a commercial standpoint, are of economic importance, as for example—wolframite, a tungstate of iron and manganese, a mineral not hitherto met with, in situ, in Canada, which has been found distributed through a quartz vein in Inverness County, Nova Scotia; 'natural soda,' which has been met with in considerable abundance in certain small shallow lakes—the deposit in one of which is estimated to represent, at present, some twenty thousand tons, not very far north of Clinton, Lillooet district, British Columbia; and an earthy variety of magnesite, the sender of which stated that it had been represented to him as having been found in considerable quantity, forming two distinct deposits, about forty miles from Quesnel Forks, Cariboo district, British Columbia—an occurrence which would appear to the writer to need further confirmation.

"8. Assays, for gold and silver, of ores from the provinces of Nova Scotia, New Brunswick, Quebec, Ontario and British Columbia, as likewise from the North-west Territory.

"9. Miscellaneous examinations, such as the examination, and, in many instances, partial analysis, of samples of bog manganese, iron ochre, iron sand, disseminated graphite, carbonaceous shale, marl, clay, and other material not included under the above headings.

Minerals examined.

"The number of mineral specimens received for examination amounted to eight hundred and sixty-one. Of these, very many were brought by visitors, who obtained the desired information in regard to them at the time of their visit, or failing that—owing to a more than mere cursory examination being necessary, or when a partial or even a complete analysis was considered desirable—it was subsequently conveyed to them by letter. The number of letters personally written

—chiefly of the nature of reports, and embodying the results of the examination, analysis or assay, as the case might be, of mineral specimens—amounted to two hundred and sixty-three; and of those received, to one hundred and twenty-three.

"Messrs. R. A. A. Johnston and F. G. Wait, assistants in the laboratory, have applied themselves with great assiduity to the work in hand, and as a result, accomplished a large amount of work, thereby rendering excellent service. The former has, apart from the carrying out of a large number of gold and silver assays, made many important mineral analyses, and likewise conducted a great variety of miscellaneous examinations; whilst the latter, in addition to numerous water-analyses, and others, of a more or less partial nature, of iron ores, manganese ores, and the like, has also conducted many miscellaneous examinations. Work of assistants.

"In the work connected with the mineralogical section of the museum I have been very ably assisted by Mr. R. L. Broadbent. He has, in addition to the general museum work—such as the labelling and cataloguing of all newly received specimens, and the maintenance of the collection generally in an orderly condition—also arranged and catalogued the collection of rocks, consisting of some seven thousand specimens, contained in the drawers under the table-cases, and placed away a further thousand specimens, for which no room could be found in the drawers, in the annex to the Survey. Museum work.

"The additions to this section of the museum—which now contains over seven thousand specimens on exhibition—during the past year, amounted to one hundred and ten. Of these the following were:— Contributions to museum.

(A.) *Collected by members of the staff, or others engaged in field-work in connection with the Survey*:—

Adams, Dr. F. D.:—

a. Phlogopite, from the townships of Monmouth and Cardiff, Haliburton county, O.

b. Corundum, from the township of Methuen, Peterborough county, O.

c. Graphite, from the township of Monmouth, Haliburton county, O.

d. Molybdenite, from the township of Harcourt, Haliburton county, O.

Ami, Dr. H. M.:—

a. Limestone, from McLean's quarry, Lime Brook, Springville, Pictou county, N.S.

b. Sand, from Britannia Bay, Ottawa River, Carleton county, O.

c. Hematite, from Grand Pré, Kings county, N.S.

Contributions to museum—*Cont.*

Bailey, Professor L. W. :—

a. Manganiferous siderite, from Peabody farm, 2 miles south of Woodstock, Carleton county, N.B.

b. Chalcopyrite and pyrite, from Bull Creek, 3 miles below Woodstock, Carleton county, N.B.

c. Pyrite, galena and chalcopyrite, from Woodstock, Carleton county, N.B.

d. Coal, from Sandstone quarries, Clifton, Gloucester county, N.B.

e. Quartz, from Greer Creek, west bank of the St. John River, nearly opposite the mouth of Eel River, St. John county. N.B.

f. Briquettes of manganese, from Dawson Settlement, Albert county, N.B.

g. Sandstone, from Rockport, Westmoreland county, N.B.

h. Sand, from Lake Utopia, Charlotte county, N.B.

i. Conglomerate, from Turtle Creek, Albert county, N.B.

j. Bituminous shale, from Baltimore, Albert county, N.B.

k. Ferruginous clay, from Hopewell Cape, Albert county, N.B.

l. Silt, from Black's Harbour, St. George, Charlotte county, N.B.

m. Pyrrhotite, from St. Stephen, Charlotte county, N.B.

Barlow, A. E. :—

a. Quartz, orthoclase, and albite, from the township of Wicklow, Hastings county, O.

b. Mica, from the township of Dungannon, Hastings county, O.

c. Quartz crystals (red), from the township of Mayo, Hastings county, O.

Dawson, Dr. G. M. :—

a. Sandstone (Laramie), from Edworthy's quarry, Bow River, about four miles above Calgary, district of Alberta, N.W.T.

b. Magnetite, from the Pot-hock mine, near Sugar-loaf Hill, Yale district, B.C.

Ells, Dr. R. W. :—

a. Pyrite, from the township of Lanark, Renfrew county, O.

b. Phlogopite, from the township of Wright, Ottawa county, Q.

Faribault, E. R. :—

a. Limestone, from Goat Lake, Chester, Lunenburg county, N.S.

b. Limestone, from Indian Point, Lunenburg county, N.S.

McEvoy, J. :—

a. Native sulphur, from three miles above Jasper Lake, district of Alberta, N.W.T.

b. Cyanite and beryl, from the mica mine seven miles south of Tête Jaune Cache, Fraser River, B.C. Contributions to museum—*Cont.*

c. Cyanite, from mountain south of Camp River, Canoe River, B.C.

Willimott, C. W.—See beyond.

(B.) *Received as presentations* :—

Ade, Wm., Ottawa, O. :—

Dolomitic limestone, Ottawa.

Bostock, H., M.P., Monte Creek Ranch, Ducks, B.C. :—

a. Chalcocite, bornite and native copper, from the Pot-hook claim, 1¼ mile north-west of Sugar-loaf Hill, Kamloops, B.C.

b. Concretionary limestone. from Wardner, Yale district, B.C.

Bousfield, Rev. Geo., Billings Bridge, O. :—

Bog iron ore, from the township of Marlborough, Carleton county, O.

Constantine, Inspector C., N.W.M.P. :—

a. Gold nugget, from Eldorado Creek, Klondike River, Yukon district, N.W.T.

b. Auriferous gravel, from Eldorado Creek, Klondike River, Yukon district, N.W.T.

c. Fragment of mammoth-tooth with embedded gold nugget, from Eldorado Creek, Klondike River, Yukon district, N.W.T.

Donaldson, Morley, Canada Atlantic Ry., Ottawa, O. :—

a. Sand, from head of Round Lake, 12 miles from Killaloe, Renfrew county, O.

b. Sand, from foot of Round Lake.

c. Sand, from the Ottawa River, about seven miles below Ottawa City.

Doucet, M. J., Grand Etang, N.S. :—

Chalcopyrite, from Cape Rouge, five miles north of Cheticamp, Inverness county, N.S.

Douglas, Captain Bloomfield, R.N.R. :—

Garnets in mica-schist from St. Paul Island, Gulf of St. Lawrence.

Ferrier, W. F., B. Ap. Sc., Rossland, B.C. :—

a. Apophyllite, from the 600-foot level, LeRoi mine, Rossland, B.C.

b. Pyrite in quartz, from the Sunset claim, near Nelson, West Kootenay district, B.C.

Contributions to museum—*Cont.*

c Quartz with tourmaline and pyroxene, from cutting on Slocan River Railway, between Slocan Crossing and Slocan Lake, West Kootenay district, B.C.

d. Gahnite (zinc spinel) in corundum, from the township of Raglan, Renfrew county, O.

Gibson, R. H., Manitowaning, O. :—
Petroleum, from Manitoulin Island, Ont.

Latimer, F. H., Vernon, B.C. :—
Auriferous quartz, from the Falcon claim, near Vernon, B.C.

Leonard, R. W., Ottawa, O. :—
a. Disseminated graphite, from twelve miles west of Kazabazua, Ottawa county, Q.
b. Calcite, apatite, mica and fluorite, from Cobden, Renfrew county, O.

McCarty, P., Calgary, N.W.T. :—
a. Chalcopyrite, from between the head-waters of Cascade and Johnson Creeks, district of Alberta, N.W.T.
b. Galena, from Castle Mountain, near Eldon station, C. P. Ry., district of Alberta, N.W.T.
c. Sphalerite with pyrite, in quartz, from Storm Mountain, Rocky Mountains, district of Alberta, N.W.T.

McDougall & Secord, Messrs., Edmonton, N.W.T., per J. McEvoy, (Survey) :—
Pyrite, from Buffalo River, Great Slave Lake, N.W.T.

McGown Mining Company, Parry Sound, O., per Geo. Burn, Manager Bank of Ottawa :—
Bornite, native gold, and galena, from the McGown Mining Co's. property, township of Foley, district of Parry Sound, O.

McGregor, Robert, Calabogie, O. :—
Sand, from Calabogie Lake, township of Bagot, Renfrew county, O.

McKillip, A. T., per W. F. Ferrier, Rossland, B.C. :—
Cerussite, from Whitewater, Kaslo-Slocan Ry., West Kootenay district, B.C.

McLellan, Allan, Ottawa, O. :—
Chalcopyrite, from the township of Mayo, Hastings county, O.

Moxley, J. E., Ottawa, O. :—
Clay concretions, from Priest Creek, township of Portland East, Ottawa county, Q.

Contributions to museum—*Cont.*

Nordenskjöld, Baron A. E., Sweden :—
Fragment of core from boring.

Rutledge, J., Ottawa, O. :—
Three crystals of phlogopite from the township of Masham, Ottawa county, Q.

Sorette, H., Bridgewater, N.S. :—
Mica-diorite, from Welsford, Queens county, N.S.

Stewart, J., Grande Prairie, B.C. :—
Chalcopyrite, from the Key claim, Grande Prairie, Yale district, B.C.

Summers, B., St. Thomas, O., per L. M. Lambe (Survey) :—
Columnar limestone, from Springbank, St. Catharines, Lincoln county, O.

Taschereau, Fortier, St. François, Beauce Co., Q. :—
Grey granite, from St. François Nord-est, Beauce county, Q.

Tisdale, Col., M.P., Simcoe, O. :—
Auriferous quartz, from Michipicoten, district of Algoma, O.

Tunstall, J. C., Vernon, B.C. :—
Auriferous quartz, from the Cariboo mine, Camp McKinney, Osoyoos mining division, B.C.

Walker, Major J., Calgary, N.W. T. :—
a. Bornite, from deposit at head of Panther River, district of Alberta, N.W.T.
b. Chalcocite, from Castle Mountain, near Eldon station, C.P.Ry., district of Alberta, N.W.T.
c. Chalcocite, from between head-water of Cascades and Johnson Creeks, district of Alberta, N.W.T.
d. Chalcocite and galena, in quartz, from Ice River, about three miles from the head, S. W. side of valley, Rocky Mountains, B.C.
e. Muscovite, from about three miles up Ice River, Rocky Mountains, B.C.

Whyte, Wm., General Supt., Western div., C.P.R., Winnipeg :—
Sandstone, from C.P.R. quarry, about three miles west of Calgary, district of Alberta, N.W.T.

Winning, B., per Wm. McInnes (Survey) :—
Auriferous quartz, from Bad Vermilion Lake, Seine River, district of Rainy River, O.

Willimott, C. W., Ottawa, O. :—
Six twin crystals of sphene from the township of Litchfield, Pontiac county, Q.

Contributions to museum—*Cont.*

Willimott, R. R., Fort Steele, B.C. :—

Cerussite, from the North Star mine, Mark Creek, East Kootenay district, B.C.

Winter, S. & Co., Moncton, N.B. :—

Muscovite, from seven miles south of Tête Jaune Cache, Yale district, B.C.

Wood, Wentworth F., Kamloops, B.C. :—

a. Native copper, from the Pot-hook claim, one mile and a quarter north-west of Sugar-loaf Hill, B.C.

b. Chalcocite, from the Grey Eagle claim, two miles and a quarter west of Nesbitt on Meadow Creek, S.W. of Kamloops, B.C.

c. Chalcopyrite, from the Key claim, Grande Prairie, Yale district, B.C.

Educational collections supplied.

Mr. C. W. Willimott has, for the most part been engaged in making up collections of minerals and rocks for various educational institutions. The following is a list of those to which such collections have been sent :—

1.	Public School, Milton, Queens Co., N.S	75	Sps.
2.	Toronto Church School, Toronto, Ont	75	"
3.	High School, Brampton, Ont	100	"
4.	" " Regina	100	"
5.	St. Patrick's School, W. end, St. John, N.B.	75	"
6.	Waterloo Academy, Waterloo, Que	75	"
7.	Brantford Young Ladies College, Brantford, Ont	75	"
8.	Free Library, Brantford, Ont	100	"
9.	Ecole St. Joseph, Montreal, Que	75	"
10.	Public School, Souris, Man	75	"
11.	Sussex School, Sussex, N.B	75	"
12.	St. Patrick's Convent, Halifax, N.S	75	"
13.	Public Library, Tweed, Ont	75	"
14.	College St. Joseph, St. Ephrem d'Upton, Que	75	"
15.	McAdam Superior School, McAdam Junction, N.B.	75	"
16.	High School, Watford, Ont	100	"
17.	Public School, Milford, Hants Co., N.S	75	"
18.	Department of Education, Toronto	100	"
19.	University of Manitoba, Winnipeg, Man	100	"
20.	High Commissioner's Office, London, Eng	19	"
21.	Laval Business College, St. Vincent de Paul, Que	4	"
22.	High Commissioner's Office, London, Eng	14	"
23.	Imperial Institute, London, Eng	5	"
24.	High School, Leamington, Ont	100	"
25.	Central School, Hamilton, Ont	100	"
26.	Collegiate Institute, Stratford, Ont	100	"
27.	Public School, Penobsquis, N.B	75	"
28.	St. Anthony's Academy, Montreal	75	"
		2,067	"

"He also made up a collection of the more important Canadian economic minerals, including building stones and marbles, for the Omaha Exhibition, and also other smaller collections of miscellaneous minerals for various foreign institutions.

Collections made by Mr. Willimott.

"Apart from this, he visited in the course of the summer—for the purpose of procuring further material for the making up of collections of the nature above referred to—the townships of Hull, Calumet, Litchfield, Maniwaki, Kensington and Egan, in the province of Quebec; and of Hawkesbury, Pakenham, Fitzroy, Renfrew, Hagarty and Calvin, in the province of Ontario.

"Whilst so engaged, he collected a large and varied assortment of minerals, comprising among others :—

	Specimens.	Weight.
Allanite	9	
Beryl, in the matrix	21	
Iron- and copper-pyrites	5	
Mica, crystals	5	
Molybdenite, in the matrix		800 pounds.
" free from gangue		37 "
Pyrrhotite		50 "
Scapolite, crystals	30	
Sphene, crystals	10	

"In addition to these he collected twenty or more mineral specimens from a coarse granite vein in the township of Calvin, among which were specimens of the xenotime—referred to in my last report, and an associated mineral which has been examined by Mr. R. A. A. Johnston and shown to be polycrase. He likewise collected some thirty specimens representing what may be referred to as the niccolite locality on Calumet Island. These include some fine specimens of niccolite (nickel arsenide), and representative specimens of the nickeliferous pyrrhotite there met with.

"The foregoing included some good cabinet specimens. These have been placed in the museum.

Quarries visited in Western Ontario.

"Mr. Willimott subsequently visited numerous localities in the Western Peninsula of Ontario for the purpose of collecting specimens of building stone, limestones employed for burning, and samples of the lime prepared from the latter; also of cements. He obtained :—

"In duplicate, fragments suitable for dressing into six inch cubes, of material employed for building purposes—of limestone from St. Marys; of dolomite from Beamsville, Thorold, Niagara, Galt, Guelph, Puslinch and Owen Sound; and sandstone from Caledon and Mono.

Samples of limestone employed for burning, and of the limes prepared from the same, from Ballantyne kilns, Galt; Kennedy's kilns and Toronto Lime Co's. kilns, Guelph; Slater's kilns, St. Marys; and Toronto Lime Co's. kilns at Limehouse and Nassagaweya. Specimens of raw cement stone, and cement prepared from the same, from Battle's works, Thorold; Usher's works, Niagara; and Toronto Lime Co's. works, Limehouse. Samples of clay, marl, and cement prepared from the same, from the Owen Sound Cement works, Shallow Lake; and of marl from Caledon; and of clay from Garafraxa.

"Whilst engaged in this last mentioned work he collected much useful information in regard to the quarries, etc. This he has embodied in the following notes:—

Notes made on quarries.

"On the 17th of October I started for Western Ontario to visit a number of quarries, lime kilns and cement works. Valuable information was in the first place obtained from contractors, stone masons and engineers in the cities of Toronto, Hamilton and St. Catharines, regarding their estimation of the more important building stones, limes and cements, the preponderance of stone used in each city and the sources from which the several materials come.

Beamsville quarries.

"The Beamsville quarries in Clinton may be considered one of the principal sources from which nearly all the stone for bridge work on the Grand Trunk Railway is obtained. At the time of my visit a large number of car-loads of dimension stone were awaiting shipment to the Victoria Bridge, Montreal. It is anticipated that 6000 yards of stone will be shipped from these quarries this year.

Queenstown.

"Queenston Quarries.—These quarries are situated on the Heights in the township of Niagara, and show a quarry face of about twenty-six feet, consisting of twelve feet of grayish dolomite underlaid by fourteen feet of bluish dolomite in beds of six inches to six feet. This stone has been used in the power house, Niagara Falls, several bridges and the Brock monument, and is shipped to Buffalo, London, Hamilton, St. Thomas, etc. The upper beds are of a warm gray colour and very fine-grained, they take a high polish, and are largely used for monumental purposes.

Cement works.

"Adjoining these quarries are the Queenston Cement Works—employing about thirty men. The cement-stone used lies immediately below the twenty-six feet of dolomite mentioned above, and has an average thickness of six feet, which has been excavated over an area of six acres. This stone is burned in four draw-kilns, each having a capacity of 350 barrels a day. The burnt stone is then carried by shoots to the crushers, then through chilled iron plates and buhr stones, and finally

bolted. At the time of my visit, about 6000 barrels of cement were in the storehouse. This company expect the output this year to be between 40,000 and 50,000 barrels. This cement has been used in Sault Ste. Marie and St. Lawrence canals, Grand Trunk and Michigan Central railways, and also to a considerable extent for local purposes.

"The Battle Cement Works at Thorold are working on a nine-foot bed of cement-stone overlain by fourteen feet of dolomite. This stone is burned at the quarry in draw-kilns, then carted in wagons to their mill in the village, about one mile. This cement is employed apparently for local uses such as the construction of silos, floorings and plastering the walls of houses. About 4000 barrels will be the output this year—240 pounds net to the barrel.

Battle Cement Works. Thorold.

"At the Melrose Quarry, Galt, a small quantity of dimension stone is being extracted. The Ballantyne Lime Works, in the same township, have in operation four draw-kilns, each having a capacity of 300 bushels. The lime, which is very white, is largely in demand in Toronto, Kingston and Galt, the output from the works depending upon requirements.

Melrose quarry, Galt.

"The Priest's, and J. Kennedy's quarries are both in operation, the former belonging to the Toronto Lime Co. These stones belong to the Guelph formation and vary in texture and colour, according to the depth from which they are taken. In the Kennedy quarry, they are working on lower beds than in the Priest's quarry, that appear to be much tougher and coarser grained. These stones are used extensively in Guelph and the western cities, London, Goderich, etc. A large Catholic church in Guelph was built with stone from the Priest's quarry. The stone is largely used also for burning and four draw-kilns are in operation, each with capacity of 340 bushels. This lime is used in all towns and cities in the north and east, as well as in Toronto. The output is about 40,000 bushels a year.

Quarries at Guelph.

"The Kennedy Lime Works in connection with their quarry have three draw-kilns in operation, each having a capacity of 300 bushels. The principal markets for this lime are Toronto, London, Goderich and Sarnia. The output this year will be about 40,000 bushels.

Kennedy lime works.

At the Elliott quarry at St. Marys, about twenty-five feet of beds have been cut, the beds varying from two inches to one foot. A large number of beds suitable for flagging might be obtained from this quarry. This stone has been used in buildings in London and Stratford as well as locally.

St. Marys.

"The Slater Lime Kilns, in the same town, have two draw-kilns in operation and ship largely to the western and northern markets. Their output this year will be about 60,000 bushels at 16 cents a bushel.

Slater kilns.

Cement works at Shallow Lake.

"The Owen Sound Portland Cement Works, at Shallow Lake in the township of Keppel—are situated in close proximity to an extensive marl swamp, which being underlaid by a blue clay, affords an admirable material for the compounding of their cement.

"This marl extends over 500 acres, and is underlain by five feet of blue clay. These two ingredients are mixed in certain proportions, then burned to a clinker, after which it is ground to an impalpable powder.

"These works which employ 150 men, have nine bottle-kilns in operation, each having a capacity of 300 bushels, consuming seven car-loads of coke and three car-loads of coal a week. At the time of my visit extensive operations were in progress in enlarging these works. This cement, known as the Samson brand, is used throughout Western Ontario and Manitoba and has been employed in the Trent Valley Canal, Sault Ste. Marie Canal, Departmental Buildings, Ottawa, etc. About 70,000 barrels will be the output this year, price $2.30 a barrel. A large number of testimonials are furnished by the company, from engineers and others all over Canada, many of whom claim that this cement is equal if not superior to any other.

Owen Sound quarry.

"The Owen Sound quarry, owned by D. Chalmers, is being worked by a small force of men, on an average four-foot bed of dolomite, which is largely used for bridge work; the Sault Ste. Marie bridge being built of this stone, as well as many others on the Canadian Pacific Railway. The underlying beds, which are very shaly, are considered only fit for burning.

Marl deposit.

"In the township of Caledon, between the third and fifth concessions, near the town-line of Garafraxa, it is claimed that a deposit of shell marl extends over 350 acres, to the depth of thirteen feet, overlain by 5 feet of peat. Adjoining this deposit in the township of Garafraxa is a bed of clay that has been tested to the depth of sixteen feet over an area of 20 acres. This property is owned by the Orangeville Cement Company, Orangeville.

Quarry at Orangeville.

"The Owen Sound Stone Company's quarry at Orangeville, in the township of Mono, is in operation with about twenty men employed. This stone is a grayish, fine-grained sandstone, occurring in beds from four to seven feet thick, overlain by four feet of limestone and fifteen feet of alluvial soil. Dimension stone seven by seven feet, and any length can be obtained. The output this year (1898), it is stated, will be about 20,000 cubic feet. This stone is sold in Toronto, Windsor, Chatham and London It has been used in the construction of the new City Hall, Toronto; also the Episcopal church at Listowel and

the Methodist church at Arthur, Ont. Mr. Isaac Nicholson who owns the property adjoining the above-described quarry, also takes out a small quantity of stone annually, for local use.

"The Limehouse Cement and Lime Works owned by the Toronto Lime Co., have three draw-kilns and eight set kilns in operation.

"The cement-stone has an average thickness of seven feet, overlain by twenty-five feet of dolomite, both varieties of stone being burned at the quarry, producing cement and lime used in Toronto and Western, Ontario.

Townships of Esquesing and Nassagaweya.

"In the township of Esquesing sandstone is quarried by Mr. Bate, and in Nassagaweya, by Mr. McGibbon. This latter quarry was hurriedly visited. In it, beds from three to thirty inches and having a depth of about twelve feet, are worked. This stone is principally suitable for sills and flagging. Some beds are spotted with iron oxide.

Lime-kiln.

"A lime-kiln belonging to the Toronto Lime Co. is also in operation in Nassagaweya. One of the two draw-kilns was at work at the time of my visit. The beds at this quarry average about four feet in thickness, having a total thickness of about fifty feet, but they are apparently very much shattered by high explosives. The product is largely used in the crushed state in making paving in Toronto. The lime made from this stone is very strong, of a grey colour, and is used in Toronto, Peterborough, London, St. Thomas, etc. The output this year will be about 60,000 bushels, priced at 10c. a bushel at kiln.

Caledon.

"In the township of Caledon, lot 1, concession 2, is a quarry known as Smeaton's quarry. The upper bed or brown-stone, (sandstone) is three feet six inches in thickness. Underlying this are two beds of gray stone, (sandstone) two feet six inches and one foot respectively. These stones are largely use for curbing and sills and have been extensively used in Toronto, Berlin, London, St. Thomas, Windsor, etc. The Parliament Buildings, New City Hall and Forester's Temple in Toronto, utilized quantities of this stone.

"The quarries and lime-kilns mentioned above comprise the more important workings on the line of travel actually followed, but much information has also been secured bearing upon adjoining quarries and workings which were not actually visited. Statistical details respecting these were also obtained, and notes on other works of the same kind, all of which hav- been handed over to the Section of Mineral Statistics and Mines.

SECTION OF MINERAL STATISTICS AND MINES.

Mr. E. D. Ingall, the officer in charge of the section, reports as follows :—

Mineral statistics.

"There is nothing new to report in regard to the work of the section, which was carried on along similar lines to those followed in former years. The preliminary Summary Statement of the Mineral Production of Canada for 1897, was completed by the 23rd of February of the current year, and issued shortly afterwards. The work of preparation of the detailed report on the Statistics and Technology of the Mining Industry for 1897 was proceeded with, and that report is now going through press.

"Besides the above matters, the time of the staff has been occupied by such general work as that of the preparation of memoranda, giving information to inquirers on a great variety of subjects regarding technical matters, relating to the economic minerals of the country. The routine work was prosecuted as far as time and means at command permitted, and some progress was made in the effort to obtain and keep posted to date our records regarding the mineral deposits, borings and mining developments, and to keep the same fyled away systematically for reference. The necessity for the keeping of such records is evident, but it involves continuous work and with the limited means at command, the end desired can be only partially attained. Apart from the time occupied in the general supervision of the work, and in connection with the preparation of the annual report, my own efforts were, during several months, directed towards the completion of the report on the iron deposits of the Kingston and Pembroke Railway district. This was brought almost to completion and will be finished as soon as the work of putting the annual report through the press is done with.

"Owing to the pressure of office work, no time was available for the prosecution of any field-work.

"We are indebted to Mr. J. D. Fraser, Ferrona Iron Works, for a valuable series of analyses of Nova Scotia iron ores published in the last report.

"Mr. A. A. Cole, senior assistant on the staff left, in January, and the vacancy thus caused was filled by Mr. Theo. Denis, in April. To these gentlemen and to Mr. J. McLeish are due thanks for their able assistance.

PALÆONTOLOGY AND ZOOLOGY.

Mr. Whiteaves submits the following summary of the palæontological and zoological work during the year 1898. Palæontology

"The MS. of the fifth and concluding part of the first volume of Contributions to Canadian Palæontology, which was commenced in 1897, was completed in June, 1898, and the part itself has since been published and distributed. It consists of 76 pages large octavo of letterpress, illustrated by three full page plates and five woodcuts. The letterpress is made up of two papers, with general title-page, letter of transmittal and index. The first of these papers is entitled 'On some additional or imperfectly understood fossils from the Hamilton formation of Ontario, with a revised list of the species therefrom,' and the second (which is an appendix to the whole volume), a 'Revision of the nomenclature of some of the species described or enumerated in previous parts of this volume, and additional notes on others, necessitated by the progress of palæontological research.' The preparation of these papers has led to a considerable correspondence with local collectors and with specialists in the United States and Great Britain. It has also instigated the presentation of several rare fossils to the museum. The specimens from Thedford and Bartlett's Mills lent by the U. S. National Museum, and referred to in the Summary Report of last year, have been returned, and the nomenclature of the species has been revised. Publications.

"The MS. of the fourth part of the first volume of 'Mesozoic Fossils' has been written, but needs a final revision before it will be ready for publication, and the drawings for its illustration have yet to be made. The part is intended to consist of an illustrated monograph on the (animal) fossils of the coal-bearing rocks of the Cretaceous system in the Queen Charlotte Islands (B.C.), based largely upon collections made by Dr. C. F. Newcombe in 1895 and 1897, but comprising also additional notes on the species collected by Mr. James Richardson in 1872 and by Dr. G. M. Dawson in 1878, with a revision of the nomenclature of this local fauna up to date.

"By permission of the Director, a paper entitled 'On some fossil Cephalopoda in the museum of the Geological Survey of Canada, with descriptions of eight species that appear to be new,' has been prepared and published in the Ottawa Naturalist for September, 1898. It is intended to republish this paper, with illustrations, in one of the Survey publications.

"The somewhat extensive collection of fossils from the Cambro-Silurian, Silurian, Devonian, Cretaceous and Laramie rocks of Manitoba Collections examined.

and the North-west Territories, belonging to the Provincial Museum at Winnipeg, which was sent to the writer last autumn for examination and identification, was named as far as practicable, during the summer, and returned. A few fossils also, have been named for Mr. F. W. Wilkins, of Norwood, Ontario.

"A preliminary study has been made of the fossils collected by Mr. J. B. Tyrrell from the Cambro-Silurian, Silurian and Devonian rocks of northern Manitoba, in 1897, and by Mr. J. McEvoy from the Devonian, Carboniferous and Laramie rocks of the Rocky Mountains in 1898.

Collections loaned.

"A few types of critical species of Canadian fossils have been lent at various times to the Professor C. D. Walcott, Director of the U. S. Geological Survey, who has been engaged on a revision of the Cambrian Lingulidæ; to Prof. A. Hyatt, of Boston, Mass., who has long made a specialty of fossil Cephalopoda; and to Miss Donald, of Carlisle, England, who is making a study of the genus *Murchisonia* and its allies.

Zoology.

"The additions to the zoological collections in the museum during the past year have been fairly numerous. Among them are a number of skins of small mammals, a few bird-skins and a set of the eggs of Townsend's solitaire, collected by Mr. Spreadborough in the Rocky Mountains last summer; a head of the 'wood buffalo' from the District of Athabasca; a black variety of the red squirrel from New Brunswick; an albino or nearly albino scaup duck from Manitoba; and a set of the eggs of the rock ptarmigan from the summit of the Chilcat Pass. A large series of recent Chitonidæ that had been lent to Professor Pilsbry during the preparation of his monograph of that family in the fourteenth and fifteenth volumes of his continuation of Tryon's Manual of Conchology, has been labelled in accordance with the nomenclature in those volumes, and returned. All the Belas in the museum of the Survey, from the Atlantic and Pacific coasts of Canada, have been lent to Prof. A. E. Verrill, of Yale University, for study and comparison.

Official duties.

"The duties of Acting Director have been performed for about seven weeks, during the Director's absence in British Columbia and Nova Scotia.

Work by Dr. H. M. Ami.

"Dr. H. M. Ami spent some time last January in instituting comparisons between the fossils described from the Devonian and Carboniferous of other parts of the world and those assigned to the same periods in Nova Scotia. Advantage was also taken of the visit of Dr. David White, of the U. S. Geological Survey, to obtain his opinion on

the large collections of fossil plants made by Dr. Ami in Colchester, Pictou and Kings counties in the province. His observations on these collections have materially assisted in ascertaining more nearly than before the precise equivalency of the horizons represented in comparison with those recognized in the United States. At a later date, while on leave of absence in consequence of ill-health, Dr. Ami visited, in company with Dr. White, portions of the Pennsylvania Coal Field, where he found the character and succession of the beds to resemble closely that met with at corresponding horizons in Nova Scotia. The Pocono formation, in particular, recognized as the lowest subdivision of the Carboniferous in Pennsylvania, containing a flora closely resembling that of the Riversdale series in Nova Scotia. The information gained at this time was of material assistance in connection with the work noted on a later page.

Nova Scotia and Pennsylvania Carboniferous compared.

"Collections of fossils from the following localities received during the past year were also examined by Dr. Ami, and preliminary lists of the species made, as far as practicable, for future use and reference.

"From the North Slope, Springhill Mines, Nova Scotia, collected by Mr. Lee Russell, 1898. Several fine slabs of fossil plants, comprising six genera and as many species from the Cumberland Coal Field.

Collections examined.

"Supposed organisms from opposite the Mouth of Mactaquac River, a tributary of the St. John River, Lower French village, county of York, N.B., collected by Prof. L. W. Bailey.

"From Shaw's Mills, Beccaguimic River, collected by Prof. L. W. Bailey. A small series of imperfect Cambro-Silurian fossils from the semi-crystalline and dark-coloured limestones of the valley.

"Preliminary studies have also been made of collections from the Cambro-Silurian limestones of the Lower Ottawa, collected by Dr. Ells and Dr. Ami.

"Dr. Ami also determined and kept records of collections brought in from time to time by various persons in the Ottawa valley, and elsewhere. Some of these have proved interesting and useful to the Department. Among these may be mentioned several collections from the Utica, Trenton and Black River formations of Billings's Bridge, obtained by Mr. W. Roger of Billings's Bridge, and a number of specimens from the Devonian and Silurian of Western Ontario. Notes on the palæontology of the district, also, were prepared for Prof. Bailey's report on South-west Nova Scotia.

"Amongst other collections examined later in the year may be mentioned, one obtained by Mr. W. J. Wilson, in a rock-cutting on the railway six miles north of Canterbury station, N.B. The rocks here

had previously been referred to the Cambro-Silurian, but some nine species of Silurian fossils have been recognized. These are noted on p. 137.

Museum work.

"A good deal of time was also given to work more or less directly connected with the museum, in part relating to specimens which have been acquired, and in part to others sent to specialists for examination. Samples of borings derived from several deep wells in Western Ontario, have also been examined and such information given as would serve to show the various geological formations penetrated by the drill, the approximate thickness of these formations, as well as the formations which lay below those traversed—with special reference to the occurrence of petroleum or gas.

Drillings examined.

"A good deal of time was also devoted to the arrangement, cataloguing and indexing of the Ethnological collections in the museum.

"In the spring, in consequence of illness, it became necessary for Dr. Ami to obtain leave of absence for three months. On his return to duty, he was assigned to field-work during the summer, upon which he makes the following provisional report:—

Duck Islands, Lake Huron.

"From July 15th to August 4th my time was occupied in the Duck Islands, and in the south-eastern portion of the GrandManitoulinIsland from Providence Bay to Owen Channel, Lake Huron, for the purpose of ascertaining whether evidence existed on which to determine the occurrence of rocks belonging to the Guelph formation in that part of the province of Ontario. The five islands that form the group called the Duck Islands, include Great Duck Island, Little Duck Island, Middle Duck or Gravel Island, Inner Duck or Thibeault Island, and Western Duck or Ile au Sable. These islands were all visited, and the first two were traversed in several directions, but no outcrops belonging to any of the Palæozoic formations were observed. The following notes bearing on the general structure and formation of the islands, however, were made:—

"The Duck Islands owe their present topography and aspect to the presence of partially eroded masses or accumulations of boulder-clay, more or less irregularly surrounded by zones or fringes of gravel and water-worn boulders of various sizes, with here and there occasional masses or deposits of sand and gravel, all of Pleistocene age.

Boulder-clays.

"The boulder-clay or till which is so extensively developed in the escarpments and higher levels of Great Duck Island, also on the south-east corner of Little or Outer Duck, and probably also in the central nucleus or axis of each of the other islands—underlying the sands and gravels found there to-day and resting probably on the Niagara—is

composed in large part of Archæan boulders mixed with a fair proportion of limestones, mostly of Silurian age. The materials which make up the boulder-clay, appear, largely, to have been carried by land-ice clear across the North Channel and the Grand Manitoulin Island, being derived from the Huronian and Laurentian rocks so characteristic of the islands of the North Channel and the mainland north of that channel.

"One of the best exposures of boulders from the till is to be seen at the south-eastern point and eastern side of Little Duck Island, where they have been freed from the till or boulder-clay by the water. These pebbles consist of white quartz, conglomerate, quartzite, jasper conglomerate, huronite and diorite, syenite, hornblendic, micaceous and granitoid gneisses, diorite, pegmatite and greenstones. These are often distinctly striated or polished, and vary in size from pebbles a few cubic inches in volume, to large masses containing fully 200 cubic feet of rock. Limestone pebbles of light yellowish-gray or drab colour and beautifully striated and polished, also occur in tolerable abundance with other *débris;* the greater portion of this limestone being evidently referable to the Niagara division of the Silurian, as developed in the more compact and heavy-bedded portion of that formation, on some parts of the Grand Manitoulin Island. Deposit of boulders.

"The till or boulder-clay of Great Duck Island, forms a rather bold and prominent ridge or bluff, that rises to a height of nearly 150 feet above the level of the lake at the northern fifth of the length of the island, and maintains a generally level surface and even trend as far as the southern third of the length of the island, from which point the surface slopes gently down to the shore; the southern part of the island being almost entirely made up of post-glacial deposits, or of fringes or zones of boulders washed out of the boulder-clay of the district, and redeposited around the shores of the lake at various periods and different levels, so as to form conspicuous zones of raised beaches at several heights above the present lake-level. Boulder-clay.

"Sand Point, the extreme north-east part of this island, is occupied by conspicuous sand-hills or dunes, of æolian origin, which extend over an area covering not less than one square mile.

"On the western side of this island and in the northern half of this side, lies Sand Cove or Horse-shoe Bay. This bay is surrounded on all sides by a fringe of sand-hills or dunes, especially at its eastern extremity. Evidence of the rapid accumulation of boulders in the south-eastern end of Great Duck Island, was noticed in several localities, but more particularly is this phenomenon observable in two prominent Sand-hills.

Beach accumulations.

features :—(*a*). At and near a wooden pier or wharf erected some 25 years ago, on the east side of Great Duck Island, opposite the fishing station on Outer Duck. The pebbles or boulders of the beach have been accumulated to such an extent along the shore and pier as to cover the sides and face of the landing and completely interfere with its use. (*b*). At the south-eastern extremity of Great Duck Island, there is to be seen a body of water, not indicated in existing maps, one mile long and three-quarters of a mile wide. This lake, whose waters lie some ten feet above the present level of Lake Huron, is formed by the closing up of the mouth of a bay, which at one time existed in this portion of the island. This bay was bounded on the east and west by two bars or low gravel ridges, that owe their origin to the accumulation of boulders derived from the glacial deposits of Little Duck and Great Duck islands. There are also seen here zones of boulders, forming raised beaches that occupy the greatest proportion of the land area in this part of the island. As many as fourteen separate zones or fringes of rounded and polished boulders, forming raised beaches, can be counted at Lighthouse Point, from the shore north, in distance of 400 yards. These zones are not regularly concentric one to the other, but coalesce or anastomose. The Manitoba Shoal, consisting of an accumulation of rounded boulders closely packed together, lies one-quarter of a mile north of great Duck Island. The strong currents that prevail in the channel between Little Duck and Great Duck islands and also along the southern extremities of these islands, together with the storm-waves of the lake, play an important part in the building up of these fringes of boulders.

Manitoba Shoal.

" These islands were probably submerged below the lake in post-glacial times, and during the period of uplift, the cliff aspect of the central or axial portion of the Great Duck, was produced by waves acting at a higher level than the present.

Middle Duck.

" Middle Duck or Gravel Island, is only a few feet above the present lake-level, and consists for the most part of post-glacial sands and gravels, probably covering denuded portions of the till or boulder-clay of the island in glacial times. The island supports a luxuriant forest of vigorous young white and black spruce. Western Duck or Ile au Sable, is also a flat, low-lying island, fairly well wooded with conifers and occasional poplars, with sandy and gravelly shoals showing boulder bars or ridges, prominent especially at the southern extremity. One bar extends a long distance into the lake. Inner Duck or Thibeault Island is the smallest of the group, is flat, and supports a forest of conifers, mostly spruce.

"The soil on Great Duck Island is varied and in the higher parts supports a rich forest of hardwood trees, maple, birch and beech, whilst in the more sandy and marginal low-lying parts of the island, conifers, including white pine, white and black spruce, cedar and other trees abound. Hay, oats and other farm crops can be raised, while small fruits flourish, and an abandoned orchard with blue plums and apples carried an abundant crop when visited. Character of soil and trees on Great Duck Island.

"In order to ascertain precisely to what geological horizon to assign the rocks that crop out on the extreme southern shore of the Grand Manitoulin Island immediately north of the Ducks, Burnt Island and Green Bay and Point were visited. At the former locality the following fossils were obtained, which indicate the presence of a coralline limestone referable to the Niagara formation and not very high up therein:— Grand Manitoulin Island.

Halysites catenulatus, (both the large and small variety).
Syringopora verticillata.
Syringopora, sp., with large corallites: probably *S. multicaulis.*
Favosites Gothlandica.
Favosites Niagarensis.
Eridophyllum, sp.
Strombodes, sp., with large corallites.

"These species are all characteristic of the Lower Niagara, and whereas the beds here, along the lake-shore at Burnt Island, are practically horizontal, and the Niagara formation as developed in the Grand Manitoulin Island is known to be at least 250 feet in thickness, it follows that, if no great faulting or dislocation occurs in the Silurian strata between the mainland and the Ducks, the formation underlying the Duck Islands is probably also referrable to the Niagara. Burnt Island.

"A careful examination was next made of four areas of Silurian rocks along the southern shore of the Grand Manitoulin Island, with a view of ascertaining if the Guelph formation of Ontario occurs on that island. The rock formations north and west of Michaels Bay, at Michaels Bay and east as far as South Bay Mouth post-office, between South Bay Mouth and the 'Slash,' and again between the Slash and Tekummah P.O., were examined, and throughout this entire area, as far as I could find, not a single characteristic species of the Guelph formation occurs, while abundant evidence was noted to refer the rocks of the whole area to the Niagara formation.

"Through the kindness of Mr. William J. Stewart, Chief Hydrographer, I was enabled to visit the west point and shore of Thomas Bay, the east shore of the same bay, the lake-shore east of Thomas Bay, also Perseverance Island, Cove Island and Flowerpot Island Islands examined.

where evidence was obtained which will enable the geological horizon to be satisfactorily determined.

"I have to acknowledge my further indebtedness to Major Gourdeau, Deputy Minister of Marine and Fisheries, to Capt. McGregor of the steamer *Bayfield*; to Messrs. W. Purvis, of Great Duck lighthouse; John Bain, of Outer Duck fishing station and W. Irving, of South Bay Mouth, for valuable assistance.

Work in Nova Scotia.

"In pursuance of instructions received, I left Ottawa for Nova Scotia on August 10th, to continue the palæontological examination of some of the rock series in that province; proceeding in the first instance to the typical sections of the Horton formation in the vicinity of Wolfville.

Silurian strata.

"Near the head-waters of Angus Brook, an interesting contact of two distinct formations is exposed. The older and underlying series consists of fine-grained red, green and mottled slates, cleaved and indurated, dipping at a high angle to the south-east, associated with beds of coarser material and sandstones. The slates hold abundance of *Dictyonema Websteri*, originally described from Beech Hill and New Canaan, near Kentville. These slates are overlain unconformably by about 250 feet of soft, unaltered and almost horizontal arkose sandstones and conglomerates, the pebbles of the conglomerate layers being made up for the most part of gray glossy slates and quartzites —generally of small size and rounded. The Dictyonema slates have been referred to the Silurian system, and from a locality about ten miles south-west of Angus Brook, Sir J. Wm. Dawson described certain coralline limestones, of Wenlock or Niagara age, associated with these slates, so that the Silurian age of these Dictyonema slates seems probable—the species resembling in many particulars the *D. reteformis*, of Hall, from the Silurian of Ontario and New York State. From the drab and dark-gray and black shales that overlie the arkose sandstones, an interesting series of fossils was obtained, including fine examples of *Cyclopteris (Aneimites) Acadica*, Dn., *Lepidodendron corrugatum*, Dn., besides ostracoda and fish remains.

Horton formation.

North shore Minas Basin.

"Some time was also spent in examining the numerous outcrops of fossiliferous strata along the north shore of the Basin of Minas, at Parrsborough, at McKays Head, Moose Creek, and particularly along the Harrington River. Foot-prints of Amphibia were found in abundance both at Parrsborough, near West Bay north-west of Partridge Island, and along the Harrington River. These are referable to the genera *Hylopus* and *Sauropus*. From the palæontological evidence obtained from the rocks in question on the Basin of Mines, I am now convinced that these rocks should be referred to the Carboniferous system. As pointed

out in reporting on my work last year, these same rocks, in other parts of the province hold a fauna and flora which has a decidedly Carboniferous facies. The ground upon which these rocks had been referred to the Devonian system was that they belonged to the same horizon as the fern ledges of Lancaster, New Brunswick, but these in turn may be said to hold a similar assemblage of forms with a decided Carboniferous facies. To whatever horizon the Lancaster plants are assigned, the rocks of the Harrington River, Riversdale and Union, and possibly of the Horton formation also must, it would appear, be assigned. Age of the rocks.

"Regarding the general results of this Devono-Carboniferous problem from a palæontological standpoint. It would appear, in reviewing the value and amount of the evidence afforded by fossils obtained during the past three seasons, that, in so far as the faunas are concerned, they clearly indicate a Carboniferous facies. These faunas include :— Palæontological evidence.

" *Insecta.*—The remains of a large wing of one of the Neuroptera has been submitted to Prof. Charles Brongniart, who states that it is referable to a well-known Carboniferous genus.

" *Phyllopoda.*—The occurrence of typical examples of the genera *Leaia, Estheria* and related genera of phyllopods, which all the world over are recognized as Carboniferous, also point to the Carboniferous age of the rocks in Canada, from which the above forms were obtained.

" *Xiphosura.*—This sub-class of Crustacea is represented in my collections by three small but eminently characteristic specimens belonging to the genus *Prestwichia*—a Protolimuloid, usually referred to the Carboniferous system.

" *Podophthalmata.*—This sub-class of the Crustacea, is represented by numerous examples of a genus allied to *Anthrapalæmon* of the Coal Measures, but as yet undescribed.

" *Amphibia.*—Numerous tracks, footprints, etc., of large-sized reptiles whose hind feet at least were furnished with five toes, occur in the collection. Some are referable to Lea's genus *Sauropus*, others to Sir. J. Wm. Dawson's genus *Hylopus* of which *H. Logani*, as represented in the collection at Ottawa, is the type. All the species of *Sauropus* previously described from North America are placed in the Coal Measures.

" *Lamellibranchiata.*—Numerous examples occur in the collections from the rocks under consideration which are clearly referable to the genus *Anthracomya*, Salter (=*Naiadites* Dn.) which genus also is characteristic of distinct zones or horizons in the Carboniferous and is closely related to forms known to occur in the undoubted Carboniferous of the Sydney, Pictou and Cumberland coal-fields of Nova Scotia.

Résumé.

"From the evidence thus far obtained, it would appear that in Nova Scotia the Carboniferous period began with shallow water conditions, producing the shales, sandstones, mudstones, marls, and grits of the Riversdale and Union series. The frequently ripple-marked and littoral character of these beds seems to indicate rapid submergences at the time of deposition and accounts for their great thickness. The fauna and flora of these series, as regards genera, are closely related to those characterizing the higher series of shales and sandstones that is separated from them by the marine Carboniferous limestone. The similarity, in my opinion, is so close, as to indicate that the whole different formations should be placed together in the geological time-scale as parts of the Carboniferous System.

"Further researches were carried on in Antigonish county, at McAra Brook and in the Lochaber Lake region—from which interesting suites of fossils were obtained.

Bone-beds, Antigonish Co., N.S.

"The bone-beds of McAra Brook, holding crustacean and fish remains, were again examined and additional exemples were obtained of a *Pteraspis*, which appears to be new (the genus having been identified by Dr. A. S. Woodward) and fragments of cephalaspidian and acanthodian species, besides indications of *Pterygotus*. The occurrence of *Pteraspis* and *Pterygotus* indicate that the beds at McAra Brook, above and below the post-road, are referable to the summit of the Silurian system or the lowermost portion of the Devonian.

Work by Mr. L. M. Lambe.

"Mr. L. M. Lambe reports as follows :—

Palæozoic corals.

"The revision of the fossil zoantharian corals, to which reference was made in the Summary Report of 1897, was proceeded with during the earlier months of the past year. Considerable progress has been made therein. The two groups of the *Zoantharia* now being studied, viz., the *Aporosa* and the *Rugosa*, include eight families known to occur in the Palæozoic rocks of Canada and are represented by twenty-six genera, embracing over one hundred species. Of these species all but nineteen have so far been revised. Special attention has been paid to the internal structure of the corals and all available material has been examined with care. I am under many obligations to Professor H. Alleyne Nicholson, who kindly lent for examination a number of the type specimens and thin sections that were used in the preparation of his two reports upon the Palæontology of Ontario, 1874 and 1875. Thanks are also due to Sir J. Wm. Dawson for having placed at my disposal some types from the Lower Carboniferous rocks of Nova Scotia, the property of the Redpath Museum, McGill University, Montreal.

"During the past year the collection of recent marine sponges from the Atlantic and Pacific coasts has been placed in proper jars and all the specimens have been relabelled. A small series of sponges from Behring Sea, collected by Dr. Leonhard Stejneger, has also been examined and the specimens named for the Smithsonian Institution, Washington.

Recent marine sponges.

"Drawings of a number of fossils from the Hamilton formation were made for plates XLVIII, XLIX and L, illustrating part V, volume I, of the Contributions to Canadian Palæontology.

"In pursuance of instructions to make further collections of fossils from the Cretaceous rocks exposed along the Red Deer River, Alberta, I left Ottawa for the North-west early in July. During the season of 1897, collections had been made by me from the rock-exposures on the Red Deer River from Red Deer village to Dead Lodge Cañon, a distance of about two hundred miles, in which the Laramie, Pierre and Belly River formations are successively exposed. The work of last summer was, however, confined to the area of 'bad-lands' lying between the mouth of Berry Creek and Dead Lodge Cañon, where it had been found that good results could be obtained, the main object of the work being to make a thorough search for dinosaurian and other organic remains in the rocks of the Belly River formation. Medicine Hat was selected as a starting point. From this place, where provisions were obtained and two men engaged, the Red Deer River was reached by wagon on the evening of July 24th and camp pitched opposite the mouth of Berry Creek. Here the 'bad-lands' extend along the river for seven or eight miles, running back on each side a distance of from three to four miles from its banks, and forming an almost circular area, through the centre of which the river flows. It had been intended to follow down the river on either side, camping at convenient points in order to facilitate collecting, but it was found that on the south-west side dry water-courses allowed of the passage of a wagon for a distance eastward of only from about one and a half to two miles, while on the opposite side any movement except on foot was prevented by the broken character of the ground. A month was spent in examining the numberless buttes and the labyrinth of deep coulées, a fortnight being given to either side of the river. Owing to the weight of the larger bones and the distance from camp at which most of them were found, the difficulty of collecting was very much increased, as they had to be carried to camp in an improvised stretcher often for some miles and over extremely rough ground. Of the fossils secured, in number dinosaurian remains and those of turtles predominated, fish remains and those of crocodiles being very scarce, as

Red Deer River district, Alberta.

Bad-lands.

were also fossil leaves, although silicified wood with the structure well preserved was everywhere abundant.

Collections made.

"The material secured during the past summer, together with that obtained in 1897, affords a comprehensive representation of the vertebrate fossils and plant remains of the Laramie, Pierre-Fox Hill, and Belly River formations in the Red Deer River district. By far the larger number of fossils were, however, secured from the Belly River beds, which are especially interesting, as representing a terrestrial fauna separated from that of the Laramie by the thick marine beds of the Pierre.

"The collection will require careful study before it can be definitely reported on, but a preliminary examination renders it possible to assign some of the remains with a tolerable degree of certainty to genera or even species already described. Much of the material is believed to represent new forms.

"The principal specimens in the collection belong to the class *Reptilia* and represent the three orders *Chelonia*, *Crocodilia* and *Dinosauria*. The remains of the last, in point of number, far exceed those of the other two orders and form the greater part of the collection.

Reptilian remains from the Belly River formation.

"Considering first the fossils from the Belly River formation, the following provisional enumeration may be made of them :—

1. Chelonia :—

   Fragments of the dorsal and ventral shield of *Plastomenus coalescens*, Cope.*

2. Crocodilia :—

   Parts of the rami of mandibles of a species of *Bottosaurus*, Agassiz.

3. Dinosauria :—

   a. Numerous maxillæ and rami of mandibles and some of the principal bones of *Trachodon mirabilis*†, Leidy.

   b. A maxilla with teeth, a separate tooth and a right ramus of a species of *Triceratops*, Marsh.‡

   c. Separate teeth and terminal phalanges of *Lælaps incrassatus*,‖ Cope.

   d. The upper part of the cranium of a species of *Nodosaurus*, Marsh.

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*Report on Geology and Resources of the Forty-ninth Parallel, by G. M. Dawson, 1875, appendix B, p. 337.

†Proceedings of the Academy of Natural Sciences of Philadelphia, vol. VIII., p. 72, 1856.

‡American Journal of Science and Arts, vol. XXXVIII., 1889, p. 173; also Sixteenth Annual Report of the United States Geological Survey, 1896.

‖ Proceedings of the Academy of Natural Sciences of Philadelphia, October, 1876, and December, 1876, p. 340.

"Of the remains referred to *Plastomenus coalescens*, a species de crib-ed by Cope from fragments collected by Dr. G. M Dawson from the Fort Union (Laramie) Cretaceous in the 'bad lands,' south of Wood Mountain, Assiniboia, the following may be mentioned specially :— Turtle remains.

"A costal plate with a surface ornamentation of shallow pits separat-ed by distinct reticulating ridges. It is ten inches long, with an aver-age thickness of between five and six lines ; two inches broad at its inner end and four inches in breadth at the outer end, where it termi-nates in a thin bevelled edge. Plastomenus.

"A large fragment, about sixteen inches broad and thirteen inches long, of the anterior end of a plastron, that had an entire breadth, when perfect, of not less than two feet. It exhibits definite deep sutural markings, is sculptured similarly to the costal plate and in outline is rounded in front and deeply concave on either side. It is about four inches thick in the central part and about an inch and a-quarter thick at the margin. Mr. R. G. McConnell, in 1882, also obtained fragments of the plastron of this species from the Belly River beds of this district. According to Lydekker* the genus *Plastomenus*, Cope is not properly distinct from *Trionyx*, Geoffroy.

"Besides the above, are marginal parts of both ends of a single plas-tron of the same species, fragments of shell that may represent other species, and vertebræ, terminal phalanges and numerous other bones of the endoskeleton of turtles.

"The remains of *Crocodilia* consist of a few small deeply pitted ob-long or oval, apparently non-articulating plates and fragments of man-dibles. The most perfect specimen of the latter consists of the anterior part, five and a-half inches long, of the left ramus of a mandible with the symphysis, showing sixteen sockets for teeth the roots of which in a few cases remain. Crocodilian remains.

"Cope has described a species *Bottosaurus perrugosus*,† from the Fort Union (Laramie) group of Colorado, from portions of jaws that strongly resemble those from the Red Deer River. Zittel places this genus with the *Alligatoridæ*, to which family he assigns also the genera *Diplocyno-don*, Pomel, and *Alligator*, Cuvier, the latter being a living genus.

The *Dinosauria* are represented by well preserved separate parts of jaws, horn-cores, bony scutes (some of large size,) vertebræ, ribs, a per-fect sacrum and parts of sacra, limb-bones, the largest of which is a femur four feet in length, and many other bones. Dinosaurian remains.

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* Manual of Palæontology by H. Alleyne Nicholson and Richard Lydekker, third edition, 1889, vol. II., p. 1118.

† The Vertebrata of the Cretaceous Formations of the West. Rep. U. S. Geol. Surv. of the Territories vol. II., 1875.

Genera represented.

"The greater number of maxillæ and separate rami of mandibles, in some of which the teeth are beautifully preserved, are referable to the genus *Trachodon* (*Hadrosaurus*), Leidy, and probably also to the original species of the genus *Trachodon mirabilis*, Leidy,* from the Upper Cretaceous (Judith River or Laramie) beds of Nebraska, U.S.A. This genus and species were founded on specimens of teeth discovered by Dr. F. V. Hayden in the bad lands of the Judith River, Nebraska. The genera *Diclonius*, Cope, and with less certainty *Thespesius*, Leidy, are regarded by some authorities as synonymous with the above genus. *Cionodon*, Cope and *Claosaurus*, Marsh, are two other upper Cretaceous genera closely allied to *Trachodon* and characterized by the same type of dentition.

"Within an area twelve feet square, a number of bones representing the remains, no doubt, of a single individual were found. They are as follows:

Remains of Trachodon.

"An almost entire fore-leg represented by a humerus (two feet four inches long), an ulna and a radius (both about two feet four inches long), a metacarpal (one foot long), phalanges, and terminal phalanges (from three to four inches broad) found together in their proper relative order and indicating an individual of large size. With these were a rib (three feet six inches long), portions of vertebræ and fragments of jaw holding teeth of the *Trachodon* type, as well as parts of the ossified rod-like tendons of the median dorsal region, resembling those referred to and figured by Marsh in his description of *Claosaurus annectens*† from the Upper Cretaceous of Wyoming. With the above occurred other bones, viz. a second humerus, a number of ribs, vertebræ and some of the large bones of the hind legs, but it was impossible to remove them, as they were in a crumbling condition. The characters of the teeth suggest an individual that probably belongs to the species *Trachodon mirabilis* or is nearly related to it. The humerus, ulna and radius bear a strong resemblance to corresponding bones of *Trachodon Foulkei*, Leidy,* a species from the Upper Cretaceous of New Jersey, closely allied to the western form.

Triceratops.

"The second species of herbivorous dinosaurian is represented by a well preserved left maxilla with teeth in place. With these may be grouped, as probably belonging at least to the same genus, an almost perfect right ramus of a mandible, sixteen inches long, without teeth in the sockets, and a separate tooth having two roots. These specimens

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*Proceedings of the Academy of Natural Sciences of Philadelphia, vol. VIII, p. 72, 1856.

†First described in 1890, from a specimen obtained by Professor Marsh in 1872 from the Cretaceous of Kansas and referred to at length in the Sixteenth Annual Report of the United States Geological Survey, part I., 1896.

are referable probably to one of the genera of the *Ceratopsidæ*, and judging from the teeth most probably to the genus *Triceratops*, Marsh* (said to be synonymous with *Agathaumas*, Cope).

"A third species of dinosaurian from the Belly River formation is represented by teeth and terminal phalanges that are referable to the carnivorous species *Lælaps incrassatus*, Cope. Lælaps.

"Taking into consideration the prevalence in the exposures of the Belly River formation on the Red Deer River of undoubted *Trachodon* remains and the scarcity of those that represent other genera, it is presumed that the majority of the larger bones that were found in this district separately or in twos and threes are referable to *Trachodon*. Among the larger bones of the collection are the following:—A complete sacrum, two feet seven inches long and seventeen inches broad at its widest part, having nine co-ossified vertebræ, and the two ends of a second sacrum that was three feet long and entire, but of which only the ends were secured owing to the fragility of the specimen. A number of femora, the largest of which is slightly over four feet long, several tibiæ of which two are three and a-half feet long, an ilium and a perfect biconcave caudal vertebra, all strongly resembling the corresponding bones of *Trachodon Foulkei*, Leidy. Reference of large bones.

"There are also many vertebræ a scapula, and a large number of other bones not yet definitely referred.

"A number of horn-cores and bony scutes of various sizes and shapes, the remnants of a protective covering, are of particular interest. With one horn-core, a foot long and between four and five inches in diameter at the base, to which a small portion of the skull remains attached, was found parts of a maxilla with teeth of the *Trachodon* type. Judging from the want of bilateral symmetry in this horn-core, it is reasonable to suppose that two horns, one on either side of the median line of the head, proceeded upward from the top of the skull; also, from the association of teeth of this type with the horn-core, it would appear that the species of *Trachodon* here represented, (possibly *T. mirabilis*, Leidy,) which with its allies have been supposed to be hornless, had well developed and formidable horns. The largest dermal (?) scute, one foot five inches long, seven inches broad and seven inches thick, consists of an asymmetrical massive base that is prolonged in front into a stout sharply-pointed spine directed slightly to one side. Horn-cores.

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*Proceedings of the Academy of Natural Sciences of Philadelphia for 1858, vol. X. p. 213.

"A slender bone three feet seven inches long, supposed to be an ischium, is very similar in size and general proportions to the corresponding bone of *Claosaurus annectens* as figured by Marsh (*op. cit*).

Head armature.

"A specimen that appears to be the upper part of the cranium of a dinosaur was found at the mouth of Berry Creek, and with it were a number of large sharply keeled plates that evidently formed part of a dermal armature. The former measures ten inches in length by nine inches in breadth, and is covered above and on the sides with flat bony plates. The dermal plates are about six inches long and three and a-half inches high, each being hollowed out behind, presumably for the reception of the anterior border of the plate immediately following. The dinosaur represented by these remains may have been a Cretaceous representative of the genus *Scelidosaurus*, and perhaps nearly allied to *S. Harrisonii*, Owen, from the Jurassic of England. The surfaces of the bony plates covering the Red Deer River specimen, show markings similar to those noticed by Marsh and described by him as characteristic of the ossicles of *Nodosaurus textilis** a Cretaceous species of a genus of *Stegosauria* related to *Scelidosaurus*.

Reptilian remains from the Laramie formation.

"The more important specimens from the Laramie series consist almost entirely of dinosaurian remains, and are more fragmentary as well as fewer in number than those from the Belly River beds.

"The order *Chelonia* is not represented amongst the specimens from the Red Deer River, but in 1881 Dr. G. M. Dawson collected from exposures of the Willow Creek (Laramie) beds on the Oldman River, Alberta, fragments of a plastron that are apparently of the same species with the specimens from the Belly River series of the Red Deer River, referred above to *Plastomenus coalescens*, Cope.

"No crocodilian remains were found in the rocks of this formation.

Dinosaurian remains.

"The bones collected in 1897 include, besides vertebræ and a number of broken femora and tibiæ, a very large tibia, four feet long, and the distal or lower end of a femur, that, judging from its breadth (sixteen inches), must have had a length in the neighbourhood of five feet. Most of these bones are thought to belong to *Trachodon mirabilis* on account of their resemblance in structure to corresponding ones from the Belly River beds.

"Fragments of jaws of *Trachodon mirabilis*, with teeth in place, were collected by Mr. T. C. Weston in 1881 on the Red Deer River in range XXI, township 32, west of the fourth principal meridian.

**Vide* Sixteenth Annual Report, United States Geological Survey, part I, page 225, pl. lxxv, fig. 5.

"In 1882 Mr. R. G. McConnell obtained a femur three feet ten inches long, from the Laramie of Scabby Butte, Alberta. It appears also to be referable to *Trachodon mirabilis.*

"Previous to 1897, the collection of dinosaurian remains from the Laramie beds of the Red Deer River included a skull of *Lœlaps incrassatus*, Cope, obtained by Mr. J. B. Tyrrell in 1884 on the west bank of Knee Hills Creek about three miles from its mouth, and a jaw of the same species collected by Mr. Weston in 1889 on the east bank of the Red Deer River at a point about twenty-one miles above Knee Hills Creek. These specimens were submitted for examination to Professor Cope * who referred them to his species described in 1876 † from teeth derived from the Fort Union (Laramie) formation of Montana and described more fully in the same year from a dentary bone from the same region.

Comparison of faunæ.

"Comparing the reptilian remains from the Belly River beds with those from the Laramie, it would appear that there are probably three species common to both formations, viz.,—*Plastomenus coalescens, Trachodon mirabilis* and *Lœlaps incrassatus*, also that these are the three forms most abundantly represented in the collection. Remains of *Plastomenus coalescens* seem to be not uncommon in both formations, those of *Trachodon mirabilis* are abundant in the Belly River rocks but are not often met with in the Laramie, whilst the reverse is the case with those of *Lœlaps incrassatus.*

" In concluding his report on 'The Invertebrata of the Laramie and Cretaceous Rocks of the vicinity of the Bow and Belly rivers and adjacent localities in the North-west Territory ‡' Mr. Whiteaves gives it as his opinion that 'the invertebrate fauna of the Belly River series seems to be essentially the same as that of the Laramie of the United States and Canada, unless more than one formation has been confounded under the latter name.' This expression of opinion is corroborated to a certain extent by a preliminary review of the vertebrate faunæ of the same formations.

Mammoth remains in Ontario.

"Toward the latter part of September, a visit was made to Muirkirk, Ontario, where it had lately become known to the Department that fossil elephantine remains had been discovered. The bones, which proved to be those of a mammoth, were purchased. Notes were taken on the circumstances attending the discovery of the bones, their posi-

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* On the skull of the Dinosaurian *Lœlaps incrassatus*, Cope, American Philosophical Society, vol. XXX., 28th May, 1892.

† Proceedings of the Academy of Natural Sciences of Philadelphia, for October, 1876, p. 248, and December, 1876, p. 340.

‡ Contributions to Canadian Palæontology, vol. I., p. 89, 1885.

tion relative to the deposits in which they were found and the physical features of their surroundings."

Contributions to museum.

The following is a list of specimens collected by or received from officers of the staff, during the year 1898 :—

Dr. R. Bell :—

About thirty fossils from the drift of the north shore of Lake Superior at Michipicoten.

J. B. Tyrrell :—

About a dozen pieces of slate with fragments of fucoids (*Bythotrephis ?*) from seven miles north of Daltons Post, Unahini River, Yukon District.

Twelve specimens of Cretaceous plants from Nordenskiöld River, Yukon District.

Specimens of fossil wood from Alsek River, Yukon District.

Set of eggs of the Rock Ptarmigan from the summit of the Chilkat Pass.

W. McInnes :—

Skull of black bear (*Ursus Americanus*) from the Rainy River District, Ont.

Bone scraper from Mameigwess Lake, in the same district.

About forty pieces of Indian pottery collected by Mr. A. Boyer at the foot of the Long Sault Rapids, on the Canadian side.

Dr. H. M. Ami :—

A large number of fossils from the palæozoic rocks of Kings, Hants, Colchester, Cumberland, Annapolis and Antigonish counties, N.S., and from the vicinity of Courtnay Bay, N.B. Among them there is a series of reptilian and other footprints, referable to the genera *Sauropus* and *Hylopus*, from the Horton formation of Kings county and shales of the Riversdale series in Colchester and Cumberland counties.

About 200 Silurian fossils from various localities on Grand Manitoulin Island, Lake Huron.

A small collection of marine invertebrates from the shores of the Avon River, near the bluff at Horton Lighthouse, Nova Scotia.

Skull of Red Fox from Manitoulin Island, Ont.

L. M. Lambe :—

A large collection of dinosaurian, turtle and crocodilian remains from the Belly River formation of the Red Deer River in the neighbourhood of Berry Creek. It includes also a few fish and plant remains.

Contributions to museum—*Cont.*

A. E. Barlow :—

Set of eggs of Loon (*Urinator imber*) from Loon Lake, Peterborough county, Ont.

Three flint arrow-heads from Blackfish Bay, Kaminiskeg Lake, Renfrew county, Ont.

J. McEvoy :—

198 specimens of fossils from the Devonian, Carboniferous and Laramie rocks at various localities in the Rocky Mountains, west of Edmonton.

A number of skins of small mammals, a few bird skins and a set of the eggs of Townsend's Solitaire, collected by W. Spreadborough in the Rocky Mountains, west of Edmonton.

D. B. Dowling :—

Pale variety of the American Hare (*Lepus Americanus*)

A fossil coral (*Diphyphyllum*) from the drift of the north shore of Lake Nipigon.

W. J. Wilson :—

About 250 specimens of Silurian fossils from the Silurian rocks six miles north of Canterbury station on the C.P.R., in Carleton county, N.B.

Prof. L. W. Bailey :—

Three small collections of fossils from the Palæozoic rocks at different localities in New Brunswick.

The additions to the palæontological, zoological and ethnological collections from other sources during 1898 are as follows :—

By presentation :—

(A.—*Palæontology.*)

Colonel C. C. Grant, Hamilton, Ont. :—

105 specimens of fossils from the Cambro-Silurian, Silurian, and Devonian rocks of Ontario.

U. S. National Museum, Washington, D.C. :—

Four specimens of *Chonetes vicina* (Castelneau) and one example of *Favosites Alpenensis*, Winchell, from the Hamilton formation of Ontario.

G. Kernahan, Thedford, Ont. :—

Thirty-five specimens of ten species of fossils from the Hamilton formation of Ontario.

Contributions to museum—*Cont.*

B. E. Walker, Toronto :—

Specimen of a large species of *Trochoceras* from the Corniferous limestone of St. Marys, Ont.

F. W. Wilkins, Norwood, Ont. :—

Specimen of *Asaphus* (*Isotelus*) *maximus*, (or *gigas*) from the Galena-Trenton limestone at Cat Head, Lake Winnipeg ; and one of *Corbicula occidentalis*, from the Laramie deposits of Alberta.

(B.—*Zoology.*)

U. S. National Museum, Washington, D.C. :—

Specimen of a rare calcareous sponge (*Grantia monstruosa*, Breitfuss) from Copper Island, Commander Islands.

Commander Wakeham, Ottawa :—

A number of marine invertebrata from Hudson Bay, collected by the "Diana" expedition.

Richard Shillington, City View, near Ottawa :—

Set of four Shrike's eggs from near Ottawa.

F. White, Comptroller N. W. Mounted Police, Ottawa :—

Head of Wood Buffalo, from near Athabasca Lake.

John Fannin, Provincial Museum, Victoria, B.C. :—

Set of five eggs of Gambel's Sparrow (*Zonotrichia Gambeli*), from Beacon Hill Park, Victoria.

W. G. Paterson, Thedford, Ont. :—

Specimen of the Star-nosed Mole (*Condylura cristata*) in the flesh.

D. Lee Babbitt, Fredericton, N.B. :—

Black variety of the Red Squirrel, shot on Miscou Island.

Dr. James Fletcher, Ottawa :—

Six shells of *Arianta Townsendiana*, from a farm at Salmon Arm, Shuswap Lake, B.C.

W. E. Saunders, London, Ont. :—

Sets of eggs of eight species of birds from various localities in Western Ontario.

L. M. Lambe, Ottawa :—

Skull of American Bison from Old Wives Lake, Assa.

Contributions to museum—*Cont.*

(*C.—Ethnology.*)

Department of Indian Affairs :—

(From Mr. James Wilson, Indian agent on the Blood Reserve, N.W.T.) :—

Medicine-pole Bag willed by "Charcoal" previous to his execution, who wished it to be "placed in a museum."

N. J. Slater, Ottawa :—

Old iron axe head dug up at Clear Lake, ten miles above Eganville.

W. R. White, Pembroke, Ont.

Two copper adzes found in 1897, by workmen excavating in C.P. R. Co's. yard at Pembroke.

W. H. Robson, Lethbridge, Alberta (per J. B. Tyrrell) :—

Stone hammer found at Stonewall, Manitoba.

F. Dunn, Barrys Bay, Ont. (per A. E. Barlow) :—

Piece of Indian pottery and six stone adzes or scrapers, from Welshman Island, Barrys Bay.

P. Kelly, Carlow township, Ont. (per A. E. Barlow) :—

Stone gouge from Carlow township, Hastings county, Ont.

By exchange :

D. W. McDonald, Edmonton, Alta.:—

Skull of Musk Ox from roof of tunnel run in the north bank of the Saskatchewan, about one mile below Edmonton.

By purchase :

(*A.—Palæontology.*)

Remains of a mammoth found on the farm of Mr. Charles Fletcher, about a mile and a-half north-east of Muirkirk, Ontario, in 1895, as follows : Lower jaw with teeth in place ; upper molars with parts of cranium ; portions of the tusks ; a few vertebræ and ribs ; part of a scapula, two humeri, an ulna and radius, and all of the bones of the hind legs, except some of the smaller ones of the feet.

A fine series of specimens of "*Lituites undatus*," from the Black River limestone at the falls of the St. Charles River at Lorette, P.Q.

A number of choice fossils from the Levis limestone at Point Levis, P.Q.

Contributions to museum—*Cont.*

Five rare fossils from the Hamilton formation of Ontario.

Specimens of forty-five species of fossils from the Cambrian rocks of Newfoundland, many of which have been recently described and figured by Dr. G. F. Mathew.

187 specimens of fossil plants and insects, some of them undescribed, from the Devonian rocks at the Fern Ledges, near St. John, N.B.

(*B.—Zoology.*)

Albino or nearly albino Scaup Duck, from Whitewater Lake, Manitoba.

Male Saw-whet or Acadian Owl, (*Nyctala Acadica*) in dark-brown and not quite adult plumage, from the forks of the Blindman and Red Deer rivers, Alberta.

Two sets each of the eggs of the Great Black-backed Gull and White-throated Sparrow, and one set each of the eggs of the Olive-sided Flycatcher, Pine Siskin, Swamp Sparrow and Magnolia Warbler, from Nova Scotia.

One Osprey's egg from Nova Scotia, and one unspotted white Murre's egg from Labrador.

(*C.—Ethnology.*)

Ninety-four objects of Indian manufacture and three Indian skulls, collected by Dr. C. F. Newcombe at the Queen Charlotte Islands.

C. Hill-Tout, Vancouver, B.C.:—

Stone pipe from Lytton.

NATURAL HISTORY.

On the work done by himself, or under his immediate control, Professor J. Macoun reports as follows :—

Work done during winter of 1898.

" After the completion of my last summary report I spent the winter months writing a catalogue of the Water Birds of Canada, which includes notices of the breeding habits and geographical distribution of each species so far as known to us. The birds of Alaska, Greenland and Newfoundland, as well as those of the Dominion itself, have been included in order to render it as complete as possible.

" A good deal of time was also spent in working up the collections of cryptogams made in the Rocky Mountains during the summer of 1897.

This with the regular routine of the office kept me fully employed until the spring was well advanced.

"My work on the Lichens of the Dominion was also advanced a stage by the collections of the preceding summer in the Rocky Mountains, and the question arose whether the 'barrens' of Cape Breton Island did not produce a lichen flora that would connect that of Quebec with that of Labrador.

"In accordance with your instructions I started for Cape Breton Island on the first of July last in order to make an examination of the flora of that part of Canada. In the summer of 1888 I made an examination of Prince Edward Island, forming a high opinion of its agricultural capabilities. This season's work has convinced me, that, in regard to agriculture, the capabilities of Cape Breton have been much underrated. While on the island I travelled in a wagon to Margaree, Cape North and Louisbourg, besides making numerous minor trips. I collected extensively at all points. As a result of my two months work I brought back over one thousand species of plants, not one of which indicated a frosty summer climate. Field work, 1898.

"I had heard much of the 'barrens' of the north end of the island, and expected to find growing on this elevated plateau many plants identical with those of Labrador, but I failed to discover any. It is true there were lakelets, ponds, marshes, bogs and bare rocks with a very varied vegetation, but nothing more arctic than could be found within thirty miles of Ottawa. No boreal plants on Cape Breton Island.

"Along the north shore, at McNeil Harbour and Aspy Bay, I expected to find boreal vegetation, but failed just as completely as on the 'barrens.' Being still unsatisfied I examined the vegetation on Boulardarie Island, at both North and South Sydney, at Mira Bay, at Louisbourg and its vicinity, and although the whole region about Louisbourg was bathed in fog and gave evidence of almost continual saturation, yet boreal vegetation was wanting.

"Three years since, Dr. B. L. Robinson, curator of the Gray Herbarium at Cambridge, Mass., made extensive collections on Newfoundland along the line of the new railway. A set of these plants was presented to our herbarium, and they, too, point to a much better climate in southern Newfoundland than has generally been attributed to it. Newfoundland climate.

"When I made my examination of Prince Edward Island, ten years ago, the agricultural standing of the island was not very high, the land although well cultivated in many places was wet and undrained and poor crops were being raised. Cheese making had been tried and had Agriculture on P. E. Island.

failed and many of the farmers saw no prospect of bettering themselves. More light has since been shed on old methods, a new start in cheese-making has been made and Prince Edward Island has now over 300 cheese factories in successful operation.

Agriculture on Cape Breton Island.

"Agriculture is much more backward on Cape Breton Island now than it was ten years ago on Prince Edward Island. The cause of this is not, however, a climatic one. Its inhabitants are not an agricultural people, and consider farming as merely an adjunct to fishing, which was formerly very profitable, but now is too uncertain to make it the chief business. The mines have also drawn many from the land. On all parts of the island where cultivation is attempted I saw good crops. Oats, wheat, barley and potatoes were excellent, but much of the hay, which was the chief crop, was poor.

"Owing to inequalities of surface there are few level fields except in the valleys of streams, and a regular system of agriculture was not observed anywhere. Generally a farm consists of pasture and hay-meadow with patches of oats, barley or potatoes scattered about without any system. Although the meadow next to the oats produced poor hay which in many cases was chiefly ox-eye daisy (*Chrysanthemum Leucanthemum*), the oats were always tall and well headed, showing that the poor hay was not the result of poor soil but of want of culture. Everywhere I went it was painfully evident that agriculture was neglected on the island, and the people were falling into the belief that their soil could not compete with that of other lands in the raising of any kind of produce.

"Farming of a better class was found on Boularderie Island, but even there, vegetables and fruits were nowhere seen. The most notable thing on the whole island was the absence of gardens containing vegetables, and, dependent on this, the absence of vegetables on the table. I asked in many localities why the farmers raised no vegetables, and was told that formerly fish were traded for vegetables, and that as the fisheries became reduced vegetables were no longer obtainable.

Fruit, grain and vegetables.

"As a result of my observations on the routes already noted, it appears that there is not only abundance of moisture both in the soil and atmosphere, but sufficient summer heat both by day and night to produce an extraordinary amount of growth in July and August. With the permission of Mr. Alex. Graham Bell, who owns 1100 acres on a point stretching into Bras d'Or Lake at Baddeck, I made a careful examination of his farm and gardens, and found that his was a real experimental farm. Wheat, oats, barley, potatoes and all kinds of vegetables were excellent, the only desideratum being better under-

draining. There was a fine orchard with abundance of fruit, the only drawback being the too great growth of new wood, a circumstance paralleled, in so far as my experience goes, only in the Fraser valley in British Columbia, where a similar equable temperature and saturated atmosphere exist.

"At Baddeck Mr. Blanchard also has both an orchard and a garden, and although the land is neither well drained nor well cared for, growth and production were wonderful. But with Mr. Bell's farm and Mr. Blanchard's garden as object lessons, scarcely any attempt is being made by others to improve the system of agriculture, and young people continue to emigrate to the New England States in search of inferior positions, while the natural resources of their own country remain undeveloped.

"This state of things is, however, not likely to last much longer, as tourists from many parts of the United States and Canada are now becoming acquainted with the possibilities of the region.

Climate suitable for fruit growing.

"As you are aware, I have had the opportunity of studying the vegetation of nearly every part of Canada, and from the relation of flora to climate I feel quite safe in predicting a great future for Cape Breton. Many years ago I spent some time in the Annapolis valley, and am satisfied that that part of Cape Breton Island about the Bras d'Or lakes is equal to the Annapolis valley as a fruit-growing country. Why the people have been so long in ignorance of their great opportunities and the capabilities of their country is not for me to say, but in the production of butter, cheese and beef Cape Breton should in each case show as good results as Prince Edward Island. Potatoes, which at present are largely imported from Prince Edward Island, are just as sure a crop in Cape Breton, and a similar amount of enterprise will produce equally good results in both places.

" As to fruit-growing a few words more may be said : Mr. Blanchard of Windsor, Nova Scotia, a leading fruit grower there, was at a public meeting in Baddeck addressed by me last August. At this meeting I asserted that the Bras d'Or lakes were as well suited for the growing of apples as the Annapolis valley. After I had finished speaking, Mr. Blanchard said that he held opinions identical with my own, and hoped that he would live to see their proof.

Equable temperature.

" According to Mr. Bell, the thermometer in winter never goes lower than 10° below zero, and often the Bras d'Or Lake is not frozen over until the end of January. The spring is late, but as the buds do not develop too early, this is really a safeguard against injury. The heat of summer is tempered by the adjoining waters, and in autumn it is maintained by the heated waters of the Bras d'Or Lakes. Middle

River, Lake Ainslie, Margaree district, and many other smaller areas are just as good as that specially referred to above, but the future of one and all lies in the education of the people to the possibilities of their country.

Distribution of trees.

" The distribution of the trees of the natural forest is much the same in Cape Breton as that found elsewhere in the maritime provinces. Generally spruce and fir are found both on hill sides and level spots, but in all cases they are on land where the soil is impervious. These trees form the bulk of the forest vegetation in the vicinity of Baddeck, but in the interior of the island and in the northern peninsula much birch is mingled with them; and beech and sugar-maple, though not so abundant, are also found in considerable quantity. The last-named trees are found chiefly on rocky slopes or on better drained soil than that on which birch grows. All the species of trees found on the island were vigorous, and in no case seemed out of range. When cleared lands are encroached upon by young growth, however, they become invariably covered with spruce and fir. This shows the necessity of draining in order to keep the land in a fertile state, suitable to the growing of crops. Unless this be done, no success can be expected.

" Fine large red oaks (*Quercus rubra*), though few in number were seen on the north side of Smoky Mountain, nearly 1000 feet above the sea. On the plateau between Halfway House and Aspy Bay, a fine tract of old forest was passed through, where yellow birch and sugar-maple constitute a large part of the growth and many trees of a large size were seen.

Climate.

" A word or two must be said of the Bras d'Or Lake and of the Little and Big Bras d'Or. Owing to the narrowness of the latter, cold sea-water can scarcely affect the lakes, so that there is an interior basin filled with warm water during the summer, which keeps the lands around it bathed night and day in an atmosphere in a more agreeable condition than that of any other locality I know of. The advance of the spring is slow, but the air is not chilled, nor does the temperature rise very high, so that there is every condition necessary to the growth of fruits requiring a fairly low summer temperature. Growth in July and August is luxuriant, and the long autumn without heat or frost is quite analogous to that which gives the Annapolis apples their high flavour and great market value.

" The real mildness of the climate can be better understood when it is known that amongst other tender shrubs, grown by Prof. Bell, rhododendrons flourish, and are not in the least injured in the winter.

These shrubs do not grow well in Ontario, except in the south-western peninsula, and even there success is not certain.

"In the neighbourhood of Ste. Ann Harbour and at Louisbourg, certain species of plants were collected that seemed to have been introduced in the period of the French occupation. Amongst these are :—*Alopecurus pratensis* (French timothy), *Angelica sylvestris*, *Senecio sylvatica* and *Scabiosa succisa*. Introduced plants.

"Before going to Cape Breton, I had, like many others, a very mistaken notion of the 'barrens' in the northern part of the island. After spending some time in the north and on the plateau, the conditions producing these barrens became evident. Along the base of the escarpment bordering the plateau, the subsoil is generally impervious, and here spruce and fir occupy the ground. The broken face of the escarpment is usually covered with broad-leaved trees, such as maple, beech and birch, because it is well drained.

"The 'barrens' themselves are classified by the fruits they produce, as, blue-berry barrens, bake-apple barrens, etc., but the cause of all is the same. The soil is but a light covering and of a peaty nature. Owing to the impervious character of the rock below, all water that falls lies on the surface, producing marshes or peat-bogs, while the higher levels or slopes may be wet or dry forest or devoid of trees; in such cases they form 'blue-berry barrens.' The 'bake-apple barrens' are great bogs covered chiefly with *Rubus Chamœmorus* (the bake-apple) and a few ericaceous shrubs. Character of "Barrens."

"That this general statement is true is verified by the streams descending from the eastern side. These run in channels cut out of the granite, and have white sand in their beds and no mud, yet all the water discharged by them is dark-coloured and is nothing more nor less than the surplus bog water that has oozed over the rim of the various depressions at higher levels.

"The 'intervales' are the river-valleys, and these always have good soil, but during very high water are subject to overflow. Here the American elm (*Ulmus Americana*) attains a large size, and gives a more western character to the country than any other object. Here also are the best farms and the future seats of the cheese and butter industry which in the near future is certain to render Cape Breton wealthy. "Intervales."

"My chief scientific work in Cape Breton was of course in connection with its flora. A number of interesting species were collected in various parts of the island, and some new points as regards distribution brought to light. An island flora is always interesting and the comparatively Natural History collections.

small number of species that were of general distribution goes to show that the majority of the forms were late comers, as very many of them were found in only one or two localities.

"In the ravines at the Big Intervale, were very many beautiful ferns, prominent among which were the Male fern (*Aspidium Filix-mas)* and Braun's fern (*Aspidium aculeatum* var. *Braunii.*) Dr. Geo. Lawson many years ago found the Male fern by Ste. Ann Harbour and on the slopes of Smoky Mountain, and here too the writer found it in abundance. Another of Dr. Lawson's finds—*Potentilla Tormentilla*—was observed by me at Port Bevis, very near where he collected it.

"Notes were made on the birds seen during the summer but no specimens were collected.

Autumn collections.

"Early in September I returned to Ottawa and at once commenced to collect and examine the fungi of the neighbourhood, working steadily at this until the season was closed by severe frost early in November. Over 600 species were collected, and the great majority were determined, but there still remain a number of undetermined forms which require study.

"Since the close of the collecting season I have been engaged in determining the mosses, liverworts, lichens and fungi collected while in Cape Breton.

Work of assistant.

"My assistant, Mr. J. M. Macoun, remained in the office during the whole year, his only collecting being in the vicinity of Ottawa. No general collection was made, his work in the field being confined almost entirely to the two genera *Viola* and *Carex*. Three species of violets new to science were discovered near Ottawa, and one that had not before been found in Canada. About seventy species of *Carex* were collected and identified.

Determination of specimens.

"The routine work increases from year to year, and the number of specimens sent for determination has grown so large that much time is occupied in it. Small collections of a few species come from all parts of Canada, and during the year several collections of from 100 to 300 species have been determined. The specimens are often far from good and the time spent in determining them is frequently out of all proportion to the value of the information gained. I cannot, however, suggest any improvement in the way this work is now done, as from the most unpromising collections valuable information as regards the distribution of our plants is often obtained.

Work of local botanists.

"The most important botanical work now being done in Canada outside our own department, is on the east and west coasts of the continent. Mr. Lawrence W. Watson is working up the flora of Prince Edward Island, and Mr. J. R. Anderson, Deputy Minister of Agricul-

ture for the province of British Columbia, is doing work on similar lines on the west coast. These gentlemen and others working with them have sent their difficult species to us for determination, and while we have been of some assistance to them, their work has added much to our knowledge of the distribution of Canadian plants.

"The botanists of South-western Ontario are also doing good work and from J. Dearness, Public School Inspector, London, Ont.; Dr. J. Carroll and J. A. McCalla, St. Catharines, Ont.; J. M. Dickson, Hamilton, Ont., and W. Scott, Head Master, Normal School, Toronto, we have received valuable contributions to our knowledge of the flora of Ontario.

Geological Survey collections.

"The most important collections made by Geological Survey parties were those brought in by Mr. Jas. McEvoy and Mr. J. B. Tyrrell. Mr. Spreadborough, who was attached to Mr. McEvoy's party, though without any special botanical knowledge, made excellent collections of the plants of the Rocky Mountains east and west of the YellowHead Pass, which may be considered to very completely represent the flora of that region. More than 500 species of flowering plants were brought back, besides many cryptogams. So far as his collection has been worked up, it includes only one new species, *Viola cyclophylla.* but the northern limit of many forms has been extended, and several plants were found by him that have not been collected since Drummond's time. His collection of skins, and notes on the fauna of the same region, add much to our knowledge of bird and mammal distribution. Mr. Tyrrell's collection of plants, though not large, included one species new to Canada and several that had not before been recorded from the Yukon District.

Published work.

"The records of new species and extensions of limits have been noted by my assistant and published either in the *Canadian Record of Science* or the *Ottawa Naturalist.* Reprints of these notes, as well as a list by myself of the cryptogams found in the vicinity of Ottawa, have been distributed to the principal natural history museums and the leading botanists of Europe and America.

"So much time has been spent on routine work, that the accumulated material of our own collecting of previous years has not yet been worked up; only 2515 sheets of specimens have been mounted, as follows:—

Canadian flowering plants	1,025
United States " "	466
Foreign " "	506
Cryptogams	518
	2,515

Plants distributed.

"The distributions from the herbarium have not been large, little time being available for this purpose. But 1740 specimens were sent out, nearly all of these being in exchange for specimens received in previous years."

Report by Dr. J. Fletcher.

Dr. James Fletcher, F.R.S.C., Entomologist and Botanist to the Central Experimental Farm, in his capacity as honorary curator of the entomological collections of the Geological Survey, contributes the following brief report:—

Entomological collections.

"I have the honour to report that the entomological collections are in good condition. The only additions made during the past year are some species from Banff collected by Mr. N. B. Sanson and some others collected by myself at the same place and in British Columbia. These referred to are all Lepidoptera. In addition I was glad to have an opportunity last autumn to secure a good series of Canadian specimens of the Rocky Mountains Locust (*Menaloplus spretus*, Uhler) together with some of its parasites. These were from southern Manitoba.

Lepidoptera at Banff.

"The collection of Lepidoptera for the Banff museum, made in accordance with your request, has been added to, and will, I trust, be of interest to the many visitors who call at the museum at Banff. Mr. N. B. Sanson has made some interesting captures. Mr. Dippie, of Toronto, has also presented a specimen of the rare *Agynuis astarte* for this collection, taken by him at Banff last summer. This species was taken in the Rocky Mountains early in this century by a collector sent out by Lord Derby; but the specimen was lost and the species was not again seen until re-discovered by Mr. I. E. Bean at Laggan a few years ago. That was the only known locality until Mr. Dippie took the specimen referred to, which, although in very poor condition, will serve to identify any captures that in future may be made at Banff.

"No collections were this year made by officers of the Geological Survey. If some of those who may go to the Yukon District could be induced to collect, every specimen sent in would be of extreme interest."

Maps.

Maps.

Mr. James White, Geographer and Chief Draughtsman, reports as follows on the mapping work and related subjects:—

"During the past year Mr. C. O. Senecal has compiled the additions to the 'Three Rivers' sheet of the 'Eastern Townships' map, and

to the 2nd edition of sheets I, II and III of the Yukon map, and autographed the map of the 'Corundum Belt.' Mr. L. N. Richard has compiled the Nottaway River map, completed the Western Nova Scotia map, and has made zinc-cut drawings for several reports. Mr. W. J. Wilson has been employed on the map of the Dominion, on general draughting work and has calculated the latitudes and departures of the surveys made by me last autumn. Mr. Wilson was detached from August 5th to October 25th to assist Mr. R. Chalmers in the area covered by the Fredericton sheet (1 N. W. New Brunswick). Mr. J. F. E. Johnston has completed the compilation of sheet 121, Ontario and Quebec. Mr. Johnston also assisted me in the field for a short time. Mr. O. E. Prudhomme has traced for the engraver seven plans of Nova Scotia gold districts, has been employed on the revision of portions of the map of the Dominion and has had charge of the stock of maps held for sale and distribution. Mr. W. M. Ogilvie was employed on general draughting work to February 28th, when he left to accept the position of mining engineer to a Yukon company. Mrs. Sparks has been employed on the cataloguing of the maps and plans since November 7th. Maps—*Cont.*

"There is at present a congestion of mapping work in the office, leading to delay in the preparation of several maps. An additional map-compiler is required to catch up with the work, particularly as the increasing demand for the maps of the Survey is rapidly exhausting them in certain districts, especially where mining development or prospecting is being carried on, necessitating the publication of revised editions of many of them. The additions and corrections required to bring these new editions up to date frequently involve almost as much labour and time as the preparation of a new map.

"During the year, eleven new maps and a second edition of the three sheets of the Yukon map were published and twenty-five maps are now being engraved or photo-lithographed. Amongst these are sheets 42 to 49 and 56 to 58, Nova Scotia, the colour-stones for which will be completed for printing as soon as certain questions connected with the geological classification are determined. A second edition of the Sydney coal-field maps is nearly ready for publication and will be issued early in 1899. Similar editions will shortly be required of the Rainy Lake, Moose River and Louisbourg sheets.

"The Glace Bay sheet has been engraved on copper and the West Kootenay and Three Rivers sheets are now being engraved. The capability of showing minuter details, its lightness and the fact that corrections and additions can be made by 'beating up' without injuring the other work, gives the copper-plate many advantages over the stone. It

Maps—*Cont.* is therefore desirable that all maps of the standard series should be engraved on copper, thus allowing the publication of subsequent editions, with corrections, with the quality of the work unimpaired.

"The compilation of the altitudes of the Dominion has been continued and much information on the subject has now been collected, which, however, requires a great deal of collation and arranging before publication. Information has been supplied to members of the staff and others who have applied from time to time.

"From March 14th to 25th was spent by me in Montreal, copying levels from the profiles in the Grand Trunk and Canadian Pacific Railway offices. It is to be regretted that the engineers of railways do not generally recognize the usefulness of such a compilation and, as has been done in the United States, furnish blue-prints of their condensed profiles. A general knowledge of the altitudes of a district through which a proposed line of railway is to run, would often save a company thousands of dollars and much time. Many of the railway profiles filed in the Department of Railways and Canals are inaccurate and deficient in information as regards the position of stations and other important points, which increases the difficulties encountered in reducing the levels to a common plane of reference and in correlating them with those of other railways.

"From September 7th to October 7th was spent in the field. Transit and chain traverse-lines were carried, by way of the Canadian Pacific Railway, from Ottawa to Sharbot Lake, 90 miles, from Carleton Junction to Chalk River, 98 miles, and by way of the Kingston and Pembroke Railway, from Renfrew to Barryvale, 16 miles. These will form base-lines for the compilation of sheets 119 and 122 of the Ontario series and, with the work of previous years, give a traverse of Ontario from Ottawa to Georgian Bay with a connection, at Kingston, with the triangulation of the U. S. Coast and Geodetic Survey. Unfortunately, circumstances prevented the extension of the Chalk River line to Mattawa which has been determined in longitude by the Department of the Interior and Quebec Government. Similar traverses were also made of the M. & O., C. A., N. Y. & O., St. L. & O., and C. P. R. (North Shore) railways in the vicinity of Ottawa, to form a basis for a map on a scale of one mile to one inch, of the city and surrounding country within a radius of ten miles.

"The following positions have been determined by the surveys of the past summer :—

	Long.	Lat.
Ottawa, flagstaff Parliament Buildings...	75° 42′ 02.″8	45° 25′ 28″
Stittsville station..................	75° 55′ 20″	45° 15′ 31″
Carleton junction........................	76° 08′ 21″	45° 08′ 09″

Maps—*Cont.*

		Long.	Lat.
Franktown station		76° 04′ 56″	45° 01′ 39″
Perth	"	76° 14′ 54″	44° 54′ 18″
Maberly	"	76° 31′ 13″	44° 49′ 57″
Sharbot Lake	"	76° 41′ 39″	44° 46′ 27″
Arnprior	"	76° 21′ 39″	45° 26′ 03″
Sand Point	"	76° 26′ 09″	45° 29′ 19″
Renfrew	"	76° 41′ 04″	45° 28′ 31″
Pembroke	"	77° 05′ 41″	45° 49′ 48″
Chalk River	"	77° 25′ 58″	46° 00′ 58″
Calabogie	"	76° 42′ 12″	45° 18′ 20″

"Below are some magnetic declinations deduced from readings of a five-inch needle on the transit :—

Ottawa, Sept., 1898	11° 45′
Franktown, Sept., 1898	11° 25′
Elmsley " "	10° 46′
Perth " "	10° 00′
Arnprior " "	10° 40′
Calabogie " "	10° 10′
Cobden " "	10° 00′
Graham " "	9° 15′
Pembroke " "	9° 20′
Petewawa " "	9° 45′
L'Amable P. O., Sept., 1896 (mean of two)	8° 20′
Ormsby " "	8° 40′
Gelert, Sept., 1895	6° 50′
Kinmount, Sept., 1895 (mean of eight)	8° 02′
Oakhill P. O. " " (mean of two)	6° 37′
Horncastle P. O. " "	6° 13′
Dalrymple P. O. " "	6° 35′
Silver Creek station, Sept., 1895 (mean of two)	5° 30′

"An enumeration of the maps published during the past year, or in course of preparation is appended herewith :—

Maps printed in 1898.

		Area in square miles
275	Yukon District and Northern portion of British Columbia—Sheet I —Dease and Stikine Rivers (2nd edition)—Scale 8 miles to 1 inch.	36,540
276	Yukon District and Northern portion of British Columbia—Sheet II —Upper Liard, Frances and Pelly Rivers (2nd edition)—Scale 8 miles to 1 inch	36,540
277	Yukon District and Northern portion of British Columbia—Sheet III —Lower Pelly River and Lewes and Taiya Rivers (2nd edition)— Scale 8 miles to 1 inch	45,680
639	Ontario—Corundum Belt in Hastings and Renfrew Counties—Scale 5 miles to 1 inch	755
624	Nova Scotia—Sheet No. 50—Moose River Sheet—Scale 1 mile to 1 inch	216
654	Nova Scotia—Sheet No. 135—Glace Bay Sheet—Scale 1 mile to 1 inch	216

Maps—*Cont.*

No.	Map	Area square miles
641	Nova Scotia—Western Nova Scotia—Scale 8 miles to 1 inch.........	6,850
622	" —Killag Gold District—Scale 500 feet to 1 inch.........	
642	" —Oldham Gold District—Scale 500 feet to 1 inch.......	
643	" —Caribou Gold District—Scale 500 feet to 1 inch.......	
645	" —Goldenville Gold District—Scale 250 feet to 1 inch....	
646	" —Moose River Gold District—Scale 250 feet to 1 inch....	
647	" —Salmon River Gold District—Scale 250 feet to 1 inch..	
649	" —Forest Hill Gold District—Scale 500 feet to 1 inch....	

Maps, engraving or in press.

No.	Map	Area square miles
	Dominion of Canada, 2 sheets, each 28″ x 34″, including the Dominion from the Atlantic to the Pacific and from the International boundary to Hudson Strait and Great Bear Lake—Scale 50 miles to 1 inch..................	3,500,000
604	British Columbia—Shuswap Sheet—Geology—Scale 4 miles to 1 inch..................	6,400
669	British Columbia—Shuswap Sheet—Economic Minerals and Glacial Striæ—Scale 4 miles to 1 inch..................	6,400
663	British Columbia—West Kootenay Sheet—Scale 4 miles to 1 inch...	6,400
664	Manitoba and Keewatin—Lake Winnipeg Sheet—Scale 8 miles to 1 inch..................	45,680
605	Ontario—Sheet No. 126—Manitoulin Island Sheet—Scale 4 miles to 1 inch..................	3,456
630	Ontario—Sheet No. 129—Missisauga Sheet—Scale 4 miles to 1 inch..	3,456
626	Ontario—Map showing the occurrences of Iron Ores and other minerals in portions of the counties of Frontenac, Lanark, Leeds and Renfrew—Scale 2 miles to 1 inch..................	1,700
667	Ontario and Quebec—Sheet No. 121—Grenville Sheet—Scale 4 miles to 1 inch..................	3,456
665	Quebec—North-west Sheet "Eastern Townships" map—Three Rivers Sheet—Scale 4 miles to 1 inch..................	7,200
593	Nova Scotia—Sheet No. 42—Trafalgar Sheet—Scale 1 mile to 1 inch.	216
598	" —Sheet No. 43—Stellarton Sheet—Scale 1 mile to 1 inch.	216
600	" —Sheet No. 44—New Glasgow Sheet—Scale 1 mile to 1 inch..................	216
608	Nova Scotia—Sheet No. 45—Toney River Sheet—Scale 1 mile to 1 inch..................	216
609	Nova Scotia—Sheet No. 46—Pictou Sheet—Scale 1 mile to 1 inch...	216
610	" " —Sheet No. 47—Westville Sheet—Scale 1 mile to 1 inch.	216
633	" " —Sheet No. 48—Eastville Sheet—Scale 1 mile to 1 inch.	216
634	" " —Sheet No. 49—Musquodoboit Sheet—Scale 1 mile to 1 inch..................	216
624	Nova Scotia—Sheet No. 50—Moose River Sheet—Scale 1 mile to 1 inch..................	216
635	Nova Scotia—Sheet No. 56—Shubenacadie Sheet—Scale 1 mile to 1 inch..................	216
636	Nova Scotia—Sheet No. 57—Truro Sheet—Scale 1 mile to 1 inch....	216
637	" " —Sheet No. 58—Earltown Sheet—Scale 1 mile to 1 inch.	21
652	" " —Sheet No. 133—Cape Dauphin Sheet—Scale 1 mile to 1 inch..................	216
653	Nova Scotia—Sheet No. 134—Sydney Sheet—Scale 1 mile to 1 inch.	216
648	" " —Mooseland Gold District—Scale 250 feet to 1 inch.....	

Maps—*Cont.*

		Area square miles
650	Nova Scotia—Fifteen-mile Stream Gold District—Scale 500 feet to 1 inch	
656	Nova Scotia—Upper Seal Harbour Gold District—Scale 500 feet to 1 inch	
	Nova Scotia—Sheet No. 53—Lawrencetown Sheet—Scale 1 mile to 1 inch	216

Maps, compilation incomplete.

Western Ontario—Sheet No. 4—Manitou Sheet—Scale 4 miles to 1 inch	3,456
Ontario—Lake Nipigon map—Scale 4 miles to 1 inch	
Quebec—Basin of Nottaway River—Scale 10 miles to 1 inch	56,800
New Brunswick—Sheet 1 N. W.—Fredericton Sheet—Surface Geology —Scale 4 miles to 1 inch	3,456
New Brunswick—Sheet 2 S. W.—Andover Sheet—Surface Geology —Scale 4 miles to 1 inch	3,456
Mineral Occurrences in New Brunswick—Scale 10 inches to 1 inch	38,000
Nova Scotia—Sheets Nos. 59 to 65, 76, 82, 100 and 101—Scale 1 mile to 1 inch	2,376
Nova Scotia—Sheets Nos. 54, 55 and 66-69—Scale 1 mile to 1 inch	1,296

Library.

Library and publications.

Dr. Thorburn, librarian, reports that during the year ended December 31st, 1898, there were distributed 7,852 copies of the Geological Survey publications, consisting of reports, special reports and maps. Of these 5,803 were distributed in Canada, the remainder, 2,049 were sent as exchanges to other countries.

There were received as exchanges 2,778.

The number of publications purchased was 161, and in addition there were 30 periodicals subscribed for.

The number of letters dealing with library matters sent out during the year, was 1,217, besides 694 acknowledgments.

The number of letters received was 1,542 and of acknowledgments 656.

The number of publications sold was 4,730, for which $1,035.77 was received.

The number of volumes bound during the year was 207.

There are now in the library about 12,500 volumes, in addition to a large number of pamphlets.

NOTE.—The books in the library can be consulted during office hours by any one who wishes to obtain information on scientific subjects.

VISITORS TO MUSEUM.

Visitors to Museum.

The number of visitors to the Museum during the year 1898 has been 33,183, being an increase on that registered during any previous year.

STAFF, APPROPRIATIONS, EXPENDITURE AND CORRESPONDENCE.

Staff.

The strength of the staff at present employed is forty-eight.

During the year the following changes have taken place :—

Mr. W. F. Ferrier, resigned.

Mr. James M. Macoun, appointed assistant naturalist.

Appropriation and expenditure.

The funds available for the work and the expenditure of the Department during the fiscal year ending the 30th June, 1898, were :—

——	Grant.	Expenditure.
	$ cts.	$ cts.
Civil list appropriation	50,600 00	
Geological Survey appropriation	50,000 00	
Boring appropriation	7,000 00	
Civil list salaries		49,904 12
Exploration and survey		18,815 57
Wages of temporary employees		11,473 93
Boring operations		7,000 00
Printing and lithography		12,939 46
Purchase of books and instruments		2,095 75
" chemical apparatus		34 20
" specimens		540 50
Stationery, mapping materials and Queen's Printer		1,076 21
Incidental and other expenses		1,404 21
Advances to explorers on account of 1898-99		17,288 15
		122,572 10
Deduct—Paid in 1896-97 on account of 1897-98 $16,250.00 Less—Transferred to casual revenue 582.02		15,667 98
		106,904 12
Unexpended balance civil list appropriation		695 88
	107,600 00	107,600 00

The correspondence of the Department shows a total of 9241 letters sent, and 8896 received.

I have the honour to be, sir,
Your obedient servant,

GEORGE M. DAWSON,
Deputy Head and Director.

ROCHE MIETTE, OPPOSITE JASPER HOUSE, ATHABASCA RIVER.

MALIGNE RIVER VALLEY, OPPOSITE HENRY HOUSE, ATHABASCA RIVER.

GEOLOGICAL SURVEY OF CANADA
G. M. DAWSON, C.M.G., LL.D., F.R.S., DIRECTOR

REPORT

ON THE

GEOLOGY AND NATURAL RESOURCES OF THE COUNTRY

TRAVERSED BY THE

YELLOW HEAD PASS ROUTE

FROM

EDMONTON TO TÊTE JAUNE CACHE

COMPRISING PORTIONS OF

ALBERTA AND BRITISH COLUMBIA

BY

JAMES McEVOY, B.A.Sc.

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST
EXCELLENT MAJESTY
1900

703

To George M. Dawson, C.M.G., LL.D., F.R.S.,
Director, Geological Survey of Canada.

Sir,—I have the honour to submit herewith a report, with accompanying map, of the country traversed by the Yellow Head Pass route from Edmonton to Tête Jaune Cache, embracing portions of the district of Alberta and the province of British Columbia. It is the result of one season's exploration.

I have the honour to be, Sir,
Your obedient servant,

JAMES McEVOY.

Geological Survey Office,
Ottawa, May, 1899.

NOTE.—*The bearings throughout this report are given with reference to the true meridian.*

REPORT

ON THE

GEOLOGY AND NATURAL RESOURCES OF THE COUNTRY

TRAVERSED BY THE

YELLOW HEAD PASS ROUTE

Introductory.

The exploration described in the following report extended from Edmonton westward through the Yellow Head Pass in the Rocky Mountains, down the Fraser River to Tête Jaune Cache, and thence to the head-waters of Canoe River, a tributary of the Columbia. The accompanying map embraces the whole of the area traversed and extends in latitude from 52° 36′ to 53° 45′ N. and in longitude from 113° 20′ to 119° 35′ W. Extent of country traversed.

During the winter of 1859, Dr. (now Sir James) Hector, in connection with the Palliser expedition, travelled westward from Edmonton to the Athabasca River and ascended that stream some distance above Henry House. The results of this expedition are given in Captain Palliser's report and maps. Previous explorations.

In 1863, Milton and Cheadle, starting from the same place, followed practically the same route, but continued westward through the Yellow Head Pass and descended the North Thompson River to Kamloops, B.C. Their description of the journey, in 'The North-west Passage by Land,' graphically sets forth the difficulties to be met with and these are as numerous to-day as they were at that time.

Explorations carried out for the Dominion Government, with a view to the discovery of a suitable route for the Canadian Pacific Railway through this pass, were commenced in 1871, and a final location line, showing no higher grade than one per cent, was completed in 1876.

In 1871, Dr. A. R. C. Selwyn, then Director of the Geological Survey, made a journey from Kamloops to Tête Jaune Cache and ascended the Fraser River some distance above Moose Lake. An itinerary of this expedition is given in the Report of Progress for 1871-72.

Notwithstanding these explorations, little was known about the country except the location of the line and the sketching of the streams in the immediate vicinity thereof. It is intended in this report to give some further information about the route and also on the Information given in this report.

form and geological structure of the neighbouring mountains. On account of the small scale on which it is necessary to publish the map, (eight miles to an inch) the contour lines had to be limited to one for every thousand feet vertical interval.

Surveys.

Paced surveys were made and connected with the railway location line wherever it was possible, and traverses have elsewhere been checked by observations for latitude with a sextant. Topographical sketches, made with compass and hand-level were taken from mountain tops, forming a rough triangulation. These, supplemented by barometrical readings were employed to determine the mountain features.

In the following descriptive part of the report, portions of the already-published Summary Report of this exploration are embodied.

Topography and Route Traversed.

The district traversed may be divided into two parts:—From Edmonton to Brulé Lake on the Athabasca River, a gently rolling wooded plain. From Brulé Lake westward, a high rugged mountainous country traversed by low valleys.

Edmonton to Lake St. Anne.

A good wagon-road runs from Edmonton via St. Albert to Lake St. Anne, and in the autumn of 1898 it was cut out as far as Pierre Grey's at the head of Island Lake, a distance of sixty-eight miles. The prairie condition that exists around Edmonton gradually disappears toward the west, and before Lake St. Anne is reached the country is, to a great extent, covered with a thick growth of poplar and cottonwood. Farming settlements are numerous the greater part of the way, but near the lake there is little ground cultivated, although what there is produces good crops.

Lake St. Anne.

Lake St. Anne is a shallow body of water the surface of which is very little below the level of the surrounding country. It is about four miles wide and six miles long to the Narrows, beyond which it is reported to widen out to a still larger body. From the old beach-lines around the lake it is evident that its waters are subsiding. Father Veqreville pointed out the place where the water stood twenty years ago. It is twelve to fifteen feet above the present high-water mark.

Island Lake.

Westward from Lake St. Anne, the road reaches Island Lake, a narrow sheet of water ten miles in length, and follows near the northern shore to Pierre Grey's at its head. This lake is the source of the Sturgeon River that flows into Lake St. Anne, and thence via St. Albert into the North Saskatchewan River. A slight depression leads from Island Lake across the watershed of the Saskatchewan and Athabasca rivers, and at a distance of six miles the Pembin

River is reached by a rather precipitous descent of 250 feet. The last settlements on the road are between Pierre Grey's and Pembina with one exception that will be mentioned further on.

Pembina River.

The Pembina is about eighty yards wide, and for the greater part of the year is quite shallow and easily fordable. In the early spring, and in time of heavy rains, horses are compelled to swim in crossing. The valley of the Pembina is worn down to a depth of 250 to 300 feet, an amount of erosion far greater than should be expected from the volume of water at the present time. From what was seen later in the season, near the source of this stream at the edge of the mountains, it seems possible that some of the adjacent mountain streams, at present flowing into the McLeod and Brazeau rivers, at one time found their way into the Pembina.

Lobstick River and Lake.

Beyond the Pembina, the route ascends quickly to the level of the surrounding country which, away from the immediate vicinity of the streams, is quite flat, and continues westward crossing the Lobstick River at a point distant ten miles from the Pembina crossing. Lobstick River is locally known as Buffalo-dung River, but the name Lobstick, here given the preference, is that used on Palliser's map and on the railway exploration plans. The Lobstick at the crossing is 290 feet above the Pembina. It is here a slow, winding stream occupying a narrow valley not more than fifty feet in depth. Below this, it makes its rapid descent to the Pembina through a narrow deepening gorge, and joins the latter stream three miles above the crossing. A narrow strip along the northern bank of the Lobstick is open and grassy, but immediately behind is an extensive peaty swamp covered with Labrador tea, small brush and occasional stunted black spruce trees.

Continuing westward, the route traverses a gradually rising country that slopes very gently northward toward the Lobstick, crossing several small tributaries of that stream. Burnt and green woods of cottonwood and spruce alternate along the way and no outlook can be obtained. Nothing relieves the monotony of the route except the recurring changes from muskeg to bog-holes with intervening stretches of deep sticky white mud. Fallen timber is plentiful throughout. The principal tributaries of the Lobstick crossed are : Two Creeks, Partridge Creek, Coldwater Creek and Little Lobstick River. These are all small streams and make little impression on the even surface of the country. Three miles beyond the Little Lobstick the main Lobstick River is again crossed. It is here a small stream flowing from the south and its source is probably not more than ten miles distant.

Lobstick River to Carrot Creek.

Leaving Lobstick River, the route crosses a very bad muskeg half a mile wide and shortly afterwards ascends to higher open rolling hills

from which the first glimpse of the mountains is obtained. The snowy summits seen to the south-west are over seventy miles distant. On the west side of these hills Carrot Creek flows northward into the McLeod River and its western tributary, Medicine Creek is followed by the trail. Five miles up, at the second crossing of the stream a good camping place is known as Government Cache.

Wolf Creek.

It is nine miles from this place to Wolf Creek, a stream twenty-five feet wide and a foot deep at this season (the middle of June). It flows due north at the crossing but its general course is north-westward to the McLeod River.

Moose Creek.

Moose Creek, another parallel tributary of the McLeod, about one-half the size of the last, is eight miles distant. Between these two streams the same partly burnt country with sticky clay soil, is relieved by several miles of narrow sand ridges. There appears to be a number of these ridges running parallel to each other in a direction N. 65° W., with intervening narrow strips of peaty swamp.

McLeod River at crossing of old railway location.

Two miles and a half beyond Moose Creek the McLeod River is reached. It is 110 yards wide and at the time of our visit not more than two feet deep at the ford. Although the volume of water is far greater than that of the Pembina, its valley is comparatively small, being only ninety to a hundred feet below the level of the country. The partly open grassy country on the north bank of the McLeod is followed by the trail seven miles to the Big Eddy. A sharp bend of the river at this place, where it is folded back upon itself, is noted for its good fishing. A species of brook trout called "Bull Trout," (*Salvelinus malma* according to Prof. Macoun) is found there in abundance.

From Big Eddy to White Mud Creek.

From the Big Eddy the river takes a semicircular bend to the south, while the trail, ascending a tributary named Sun-dance Creek, joins the river again near White Mud Creek, eleven miles distant. At White Mud Creek there are half a dozen small log cabins used occasionally by half-breeds and Indians as winter quarters. The railway location line follows the southern bank of McLeod River to the Big Eddy and crossing there it ascends Sun-dance Creek for eight miles. Thence it continues westward to the Athabasca River without again touching the McLeod.

Prairie flats along McLeod River.

The trail again follows the north bank of the McLeod from White Mud Creek, for a further distance of thirteen and a half miles, to a place formerly known as Plum Pudding Cache, now called the 'Leavings.' This is an excellent camping ground with a wide prairie flat of rich grass, but it is no great exception to the general rule, as good

pasturage is to be found at short intervals along the whole route The conditions in the immediate vicinity of streams are best suited to the growth of grass, as the better drainage in those places permits the escape of the excess of surface water, which, in flatter parts is retained by the impervious clay soil.

Course of the river.

From the 'Leavings' the McLeod turns southward toward the mountains, forming by its windings, when plotted on the map, the profile of a human face looking westward. On this profile the 'Leavings' would represent a point at the top of the forehead, and the bottom of the chin would be distant twenty-five miles in a straight line to the south. A large fork, half the size of the main stream, comes in at the point of the upper lip. A reference to the map will show the application of the above comparison.

Trail from McLeod River to Athabasca River.

The route continues westward from the 'Leavings' across the watershed between the McLeod and Athabasca rivers. It is formed by a slightly rolling ridge, decreasing in elevation toward the north. It is deeply drift-covered, and, where crossed, rises gently to a height of 940 feet above the McLeod or 1,340 feet above the Athabasca. The elevation of this summit above sea-level is 4,640 feet, or 917 feet higher than the summit of the Yellow Head Pass. A few miles to the north, where the railway line was finally located, the ridge is crossed at a much lower elevation. In a straight line, the distance between these rivers is under ten miles. The trail, however, turning south-westward along the western slope of the ridge, reaches the Athabasca at the mouth of Sandstone Creek, a point twenty miles distant from the 'Leavings' of the McLeod.

All this country has been overrun by fire and much valuable timber has been destroyed. It is now a wilderness of bare trunks. On the western slope of the watershed some very bad muskegs have to be crossed. Here, as well as generally elsewhere along the route, the trail follows pretty closely the one made during the railway exploration, but windfalls are numerous, and long detours are necessary. The corduroy laid down at that time across the muskegs, is now in such a bad state of preservation as to be dangerous for animals, and it is preferable to trust to the natural surface of the muskeg on either side.

Climate of country along eastern edge of mountains.

The climate of the country traversed between the Pembina and Athabasca rivers may be said to be a wet one, but as the bottom of the Athabasca valley is approached, evidences of a change become apparent, such as, smaller and more scattered timber, steeper slopes on side-hills and cut-banks of streams and a marked indication of drier conditions in the vegetation. This change is more noticeable farther up

the valley, and is most pronounced from Jasper House to Henry House. The change is evidently due to the greater effect of the Chinook winds in the proximity of the mountains, and is here so marked because of the lowness of the valley, which is only about 3,000 feet above sea-level. This permits a great descent of the air coming across the mountains, and the result is correspondingly great dryness and warmth.

Sixty miles to the south-east, at the edge of the mountains on the Brazeau River, where there is a similar abrupt descent but not to such a great depth, as the elevation of the plateau country outside the mountains is over 5,000 feet, the effect of these winds, while still appreciable, is not by any means so pronounced.

Views of Rocky Mountains.

Several points on the route across the McLeod-Athabasca watershed afford good views of the mountains, which have a very barren appearance. Bare limestone cliffs and steep rocky slopes meet the eye. For the most part these are without any covering of trees. Although trees are frequently found at an altitude of 6,000 feet above sea-level in sheltered valleys, the steeper slopes, and those exposed to the full force of the winter winds do not support a growth of trees above 5,000 feet and often not even to that altitude.

Athabasca River from Sandstone Creek to foot-hills.

Ascending the Athabasca from Sandstone Creek, it is four miles to Ne-kas-pi-kwat (corrupted into Cache Pecotte) near Hardisty Creek, where a branch route crossing the river turns northward to Smoky River. The valley of the Athabasca is wide and flat, with an abundance of grass and having in parts a light growth of scattered pines and some heavier spruce woods. The slope of the south-west side is so gentle that at a distance of a mile back the elevation is not more than a hundred feet above the river. The same characteristics continue up to Prairie Creek, a distance of six miles farther. Here the river bends slightly more to the west for a distance of eight and a half miles, where it issues from Brûlé Lake. This lake is an enlargement of the river seven miles long and half a mile to a mile in width, lying north-and-south. The trail does not follow this detour of the river and lake but instead ascends Prairie Creek for nine miles, then turns more toward the west across Drystone Creek to Fiddle Creek which flows into the Athabasca at the head of Brûlé Lake.

Brûlé Lake.

Up to the mouth of Prairie Creek there is no approach to a mountainous condition, the hills in the vicinity of the river nowhere rising more than four or five hundred feet above it, but as that stream is ascended the ridges that run at right angles to its course become more elevated, although still rounded in outline. Between

the upper part of Prairie Creek and Drystone Creek, Folding Mountain, the first foot-hill of the Rocky Mountains, rises up. From Fiddle Creek upward, high rugged mountains stand up boldly on each side with vertical cliffs and steep rocky slopes, leaving a flat-bottomed valley, one to two miles wide, through which the Athabasca River winds it way, seldom in one united stream, but lost in a network of sloughs. The trend of the mountain ranges is S. 60° E. to S. 70° E. following the strike of the rocks, and the confluent streams having the same direction are generally arranged in opposite pairs, each pair occupying one continuous valley crossing the main valley at right angles. A good example of this is Rocky and Stony rivers that join the Athabasca near the site of Jasper House at the foot of Jasper Lake.

In the mountains.

The Athabasca is sometimes crossed about three miles below the mouth of Rocky River. In very low water it can be forded at that point. There is a trail on each side of the river from there to Henry House. In order to continue up the east side of the river it is necessary to ascend the mountain side 1100 feet to get around a smooth rocky point that comes down to the water's edge. The descent of the slope on the other side is very precipitous to the bank of Rocky River. Where Rocky River was crossed near the mouth it was divided into ten separate channels and was barely fordable (July 2).

Trail on east side of river.

Just below the mouth of Rocky River, on the opposite side of the Athabasca, is the site of Jasper House. The original buildings have long since been destroyed by fire, but a log cabin of more recent date still stands to mark the spot. Jasper Lake, which begins just above Rocky River, is a similar body of water to Brûlé Lake, five miles long and a mile in width. The long narrow sandy ridge that forms the eastern shore, cuts off from the main body of the lake a smaller sheet of water, between it and the base of the hills, called Fish Lakes. The sandy ridge is from a hundred yards to a quarter of a mile wide. Its present form is due to the agency of the wind drifting up the fine silty sand from the beach and dropping it on the top of the ridge. On the wider part of the ridge some hollows contain shallow ponds. About three miles up the lake the ridge is cut by a stream carrying the waters of Fish Lakes into Jasper Lake.

Site of Jasper House.

Jasper Lake.

The drifting action of the wind may be noted along the river for some miles above the lake forming very narrow ridges five to ten feet high along the banks and affording dry ground for the passage of a trail. On the east shore of Brûlé Lake similar action appears to be going on.

Drift action of wind.

The direction of the Athabasca valley from the outlet of Brûlé Lake to a point a few miles above Jasper Lake, a distance of twenty-three miles in a straight line, is S. 30° W. It then changes to S. 15° E. to Henry House a further distance in a straight line of nine miles. Snaring River coming in from the west, is the only important tributary on this last course. Henry House, or Athabasca Dépôt as it was called during the railway exploration, was situated on the west bank of the Athabasca half a mile above the mouth of Maligne River. Nothing is to be seen there at present except the ruins of its chimneys.

Site of Henry House.

Maligne River.

The Maligne River, flowing into the Athabasca from a direction S. 65° E., is a swift stream, unfordable except at a very low stage of water, and possesses no extraordinary features for the first mile and a half above its mouth. Then begins a narrow winding gorge from fifty to a hundred feet deep and fifteen to twenty feet wide. The rock walls at the top of the chasm have partly closed over since it was cut out and in places are almost touching, boulders lodged in the creviçe apparently preventing them from closing altogether. On reaching the level of the valley above the gorge, 350 feet above the Athabasca, it is seen that the volume of water is only about one-eighth of that of the stream below. The remainder evidently flows through an underground channel the outlet of which can not be clearly distinguished. It appears to issue from several passages. Medicine Lake, drained by this stream, is eleven miles distant, and it is reported that the greater part of the water flows all the way by an underground passage, only the excess of water in flood-time and that of the small tributary streams being on the surface.

Underground channels.

Farming land near Henry House.

Two miles and a quarter below Maligne River, on the west side of the Athabasca, a piece of land has been taken up by Mr. Swift, who has demonstrated that the country is capable of producing wheat, potatoes, and various kinds of vegetables. On September 2 he had harvested a crop of two kinds of wheat and his potatoes were of good size and quality. A great part of the Athabasca valley would make good farming land, the higher ground, however, would require irrigation. Grasshoppers are in some seasons numerous enough to be troublesome.

Miette River.

Miette River, which comes from the Yellow Head Pass, joins the Athabasca five miles above the Maligne. Its course is almost due east. On the south side, mountains up to 8,000 feet above sea-level, rise with uniformly steep slopes from the river, broken into by two valleys carrying rapid tributary streams into the Miette. To the north, after the first rather abrupt rocky rise of 600 to 700 feet, there is only

a slight increase in elevation for three or four miles, leaving a long strip of flat country dotted with ponds and swamps, the eastern end of which has been called Caledonia valley. The timber on this side has been practically all destroyed by fire but on the south side considerable areas of green woods still remain. The trail ascending the Miette runs along the rocky ridges near the stream and through windfalls of small pine for a few miles, then descending to the river-flat it crosses the stream four times in a distance of three miles, in order to avoid steep rocky banks. The first crossing is too deep to ford except at low stages of the water. The fourth crossing is eight miles in a straight line from the Athabasca. Just below it two large tributaries fall into the Miette, one from each side.

Trail up the Miette.

A mile above this, the river-bottom widens and the stream takes a winding course through marshes and meadows, half a mile to a mile wide. Fourteen miles in a straight line from the Athabasca, Derr Creek the largest tributary of the Miette flows in through three separate mouths. The valley is here wider than elsewhere and the dry open tract of grassy land between the branching mouths of Derr Creek is known as Dominion prairie. For two miles farther the valley continues wide and flat, a soft marsh occupying the whole width, forcing the traveller to climb along the timber-strewn hillside and across angular rock-talus at the foot of cliffs. Beyond this the stream again takes a steeper grade and three miles from Dominion prairie it is crossed for the last time. The Miette is here scarcely one-third the size that it is near its mouth.

Upper part of Miette.

At the place where this last crossing is effected the channel is blocked by log-jams, and the stream is divided into several branches running among the trees. When the last of these branches is crossed it is suddenly realized that the summit of the Yellow Head Pass has been reached, as at high stages some of the Miette water empties by this branch into the waters of the Fraser River. The altitude of the pass is 3,723 feet above sea-level, according to the railway survey. It is distant seventeen miles from, and 400 feet above, the Athabasca River. The pass, and valley for some distance on each side of it, are covered with heavy spruce timber that has escaped fire so far.

Summit of Yellow Head Pass.

From the summit, the route follows the flat bottom of the valley inclining gently downward in a south-westerly direction to Yellow Head (or Cow-dung) Lake, distant two miles and a half from, and a hundred feet below, the pass.

Yellow Head Lake extends four miles south-westerly and has an average width of half a mile, with two narrows near the lower end.

Yellow Head Lake.

The route proceeds along the north-west shore, passing through a thick windfall of heavy spruce timber on the way. The principal feeder of the lake is a stream from the south-east coming in a third of the way down the lake. This stream has two branches, one on each side of a conical mountain 9,000 feet high standing three and a half miles back from the lake. For a long distance on each side of the pass, the bold cliffs of Yellow Head Mountain are prominently in view. It stands guard over the pass which bends southward around its base. From the summit of this mountain a good view is obtained up the Fraser River and it is seen to take its rise, as its muddy waters indicate, in glaciers on high mountains, some twenty miles to the south. Fifteen miles to the south-east, the black ragged peaks of Mt. Geikie, 11,000 feet high, are strikingly noticeable, while to the north castellated summits over 10,000 feet in elevation cut off a more distant view.

Mountain peaks.

Yellow Head Lake to Moose Lake.

A small stream a mile in length carries the water of Yellow Head Lake into the Fraser River, which is here a large rapid muddy stream, unfordable at this season. The trail leads down the wide and partly open valley of the Fraser which trends N. 60° W. from this point. The river hugging the base of the steep mountain sides to the south, leaves a gently-rising slope on the north, half a mile or more in width. A few miles down, the timber becomes larger and thicker and at a distance of twelve miles from the pass the first of the freshly burnt country begins. Black, burnt forest continues almost without inter ruption to Tête Jaune Cache, the greater part of it having been set on fire early this season (1898).

Fourteen miles from the pass, a large stream called Grant Brook flows in from the north. It is about fifty feet wide and very swift. Three miles below this Moose River comes in also from the north. This is a rapid stream 150 feet wide, but is easily fordable except at high water. The head of Moose Lake is situated two and a quarter miles below the crossing of Moose River.

Streams flowing from Selwyn Range.

The distance between this part of the Fraser and Canoe River is only eighteen miles south-westerly in a straight line. The intervening range of mountains, to which the name of Selwyn Range is given, delivers most of its waters into the Canoe and McLennan rivers to the south-east, leaving a precipitous descent on the other side from the watershed to the Fraser River. This slope to the Fraser yields numerous short streams none of which appear to be more than seven or eight miles in length. One stream that joins the Fraser between the mouths of Grant Brook and Moose River, affords a picturesque glimpse of a waterfall, a short distance from its mouth. Along the valley of this

stream and the opposite one flowing into Canoe River, named Price Creek, the Indians are reported to have travelled with horses, for a short cut from Canoe River to the Yellow Head Pass. A stream falling into Moose Lake near its head, with its opposite stream Avalanche Creek, makes another gap in this range, which although lower than the one just mentioned, has an elevation of over 6,000 feet above the sea.

Moose Lake that receives and sends the Fraser waters, without any change of direction, is seven and a half miles long and a mile wide near its head, narrowing gradually toward the outlet. The mountains to the south of the lake rise abruptly from the water's edge, while on the north a stony slope of moderate inclination runs back for a considerable distance, increasing to a mile or more at the western end, before the steeper rocky slopes of the Rainbow Mountains begin. No streams of any importance come in from the north, as Moose River, bending westward, drains the Rainbow Mountains from behind. Viewed from a distance these mountains have a gorgeous appearance of red and yellow and hence the name given. Moose Lake.

Issuing from Moose Lake the Fraser moves slowly along in a wide stream for two or three miles, then it narrows and, taking a steeper grade, hurries rapidly downward. Two and a half miles below the lake, the old railway location line crosses from the north to the south side of the river. Some distance further on, the valley becomes more confined, as the mountains on the north side now close in upon the river, similarly to those on the south; and, at a distance of eight miles in a straight line from the lake, the trail is forced to seek a passage by a narrow foothold scooped out of the face of crumbling rock overhanging the river. Beyond this the valley opens out to a wide basin-like flat. In this flat and fourteen miles below the lake the first of two large northern tributaries, a mile and a half apart, joins the Fraser. Fraser River below Moose Lake.

This stream, known as the Grand Fork, is 100 feet wide with moderate current and appears to be always easily fordable. There is said to be a lake on this stream about six miles up, and to it may be due the regularity of flow and the absence of any appearance of freshets. The westerly tributary called Swift-current River is an erratic turbulent stream fed by glaciers. It may sometimes be forded without difficulty in the morning and the same evening be utterly impassable. Grand Fork.

Looking up Grand Fork is the most imposing view met with on the whole route. Great mountains are on every hand, but over all stands Robson Peak, 'a giant amongst giants and immeasurably supreme.' This, as well as the following, is from the description Robson Peak.

of the mountain by Milton and Cheadle.* 'When we first caught sight of it, a shroud of mist partially enveloped the summit, but this presently rolled away, and we saw its upper portion dimmed by a necklace of feathery clouds, beyond which its pointed apex of ice, glittering in the morning sun, shot up far into the blue heaven above.' The top of the mountain is usually completely hidden and rarely indeed is it seen entirely free from clouds. The actual height of the peak is 13,700 feet, or 10,750 feet above the valley. The face of the mountain is strongly marked by horizontal lines, due to the unequal weathering of the rocks, and has the appearance of a perpendicular wall. From the summit to the base on the Grand Fork, a height of over 10,500 feet, the slope is over 60° to the horizontal.

Height of the mountain.

Although Robson Peak has been long known, its height had never been determined, nor was it supposed to be particularly notable in that respect, but now since the height of Mts. Brown, Hooker and Murchison have been proved to be greatly exaggerated, it has the distinction of being the highest known peak in the Canadian Rockies.

It is interesting to note that in a paper read before the Royal Society of Canada by Dr. G. M. Dawson the following paragraph occurs :—

'The Kamloops Indians affirm that the very highest mountain they know is on the north side of the valley at Tête Jaune Cache, about ten miles from the valley. This is named Yuh-hai-has-kun, from the appearance of a spiral road running up it.' The mountain referred to is undoubtedly Robson Peak, as it is only fifteen miles north from the valley at Tête Jaune Cache. The 'spiral road' is probably an Indian's imperfect description of the horizontal lines on the face of the mountain. As far as can be learned no one, either Indian or white, has ever succeeded in reaching the summit.

Fraser River from Grand Fork to Tête Jaune Cache.

A little above the junction with the Grand Fork, the Fraser changes its course of N. 60° W., which it holds all the way from where it is first reached opposite Yellow Head Lake, to one of S. 40° W., for six miles, and then to due west for a further distance of five miles, to Tête Jaune Cache. The valley gradually narrows again during the first of these two courses, and on the last stretch the river is confined between high gravel banks, and toward the cache by low rocky bluffs.

At Tête Jaune Cache, the Fraser emerges into the great valley that runs from the 49th parallel to this point and continues beyond in the same general direction of N. 40° W. A good statement of the

* The North-West Passage by Land, pp. 252-253.

MOUNTAINS NORTH OF MOOSE LAKE, UPPER FRASER RIVER.

ROBSON PEAK, GRAND FORK, FRASER RIVER.

information to date concerning this valley is given by Mr. McConnell in the Annual Report for 1894, vol. VII. (N.S.) p. 18c, where it is described as 'one of the most important topographical features of British Columbia.' It preserves its main characteristics so well throughout, regardless of what stream occupies any particular part of its length, that here there is a striking resemblance to the part of it seen at Donald on the Canadian Pacific Railway. This portion of the valley has never been described before, but the description of Mr. McConnell, although given with particular reference to other parts of its length, is equally applicable here. The only alteration to be made is that the height of the Columbia-Fraser watershed should be 2,563 feet instead of 2,900. No rock-cutting is going on at the present time, but, as elsewhere in such cases, narrow secondary valleys are being cut out in the stratified gravels and sands.

McLenna River.

The Fraser now bends to the north-west along this valley, receiving a tributary, the McLennan River, from the south-east. The McLennan takes its rise in a shallow lake in the middle of the valley called Cranberry Lake, fourteen miles from the Fraser, but receives most of its waters from the adjacent mountains. It is about a mile from the eastern end of Cranberry Lake to the Canoe River, that comes in from the south-west and flows down the main valley, in the opposite direction to the Fraser, to join the Columbia River at Boat Encampment. The portion of the valley between the Fraser and Canoe rivers is much wider than its continuation in either direction, having an average width of four miles. It is very level from side to side and a cross-section would show only a gentle depression toward the centre The slightly more elevated strips of ground near the sides, are for the most part dry and sandy, covered with an open growth of small black pines, while the richer soil of the middle part shows much open grassy land, with some good spruce timber near the McLennan River.

Climate of valley.

The climate of the valley is drier than that of the upper part of the Fraser, as there is little rainfall during at least two months in the hottest part of the summer, but in the richer and lower lands there is sufficient moisture to produce good crops without irrigation. It is safe to say that at least a fourth of the area of the valley would make rich farming land.

The two principal tributaries of the McLennan River, fall into the valley a short distance below Cranberry Lake, the north-eastern branch, Swift Creek, being somewhat smaller than the westerly one, called Mica Creek, which takes its rise in the high glacier-clad mountains on the south-west side of the valley. On the north-east side, the mountains

Glaciers in Selwyn Range.

of Selwyn Range, rising to 8,000 and 9,000 feet above sea-level, have numerous small glaciers, and the streams are, however, all more or less laden with fine silt and mud. On the opposite side these conditions exist on a far greater scale and snow-clad and glacier-laden mountains rise higher and higher, far as the eye can reach in a south-westerly direction. Erosion is going on very rapidly. Every stream is choked with mud and detached fragments of rock are heard at short intervals crashing down the slopes. The height of several summits in these mountains was ascertained to be nearly 11,000 feet, and some of the more distant peaks appear to go beyond that figure.

Height of timber line.

The height of the limit of the growth of timber is, on the average, somewhat under 6,000 feet above sea-level. It varies a great deal, however, according to the exposed or sheltered nature of the place. In inner sheltered valleys the limit reaches an altitude of 6,500 feet and over, while the unprotected parts receiving the full force of the cold winter winds rarely have any timber above 5,500 feet and frequently not over 5,000 feet.

Cranberry Lake to Camp and Canoe rivers.

Canoe River is crossed near where it bends to the south-west, opposite the eastern end of Cranberry Lake. The water-level at the crossing is 135 feet below the level of Cranberry Lake and sixty feet higher than the Fraser River at the Cache. Cranberry Lake has an elevation of 2,563 feet above sea-level. Twelve miles distant, in a direction a little south of west Canoe River takes its rise issuing from beneath two great glaciers. Receiving several tributaries from similar sources, it is joined by Camp River two and a half miles above the crossing. Camp River comes from a low pass to the south-east, heading near Albreda Lake, the source of a tributary of the North Thompson River. The main branch of the North Thompson takes a circuitous course around and beyond the head of Canoe River just outside the south-west corner of the map. The passes leading from Canoe River to the North Thompson are occupied by large glaciers, and, owing to the extremely rugged character of the mountains, are difficult to cross. As a natural consequence of the glacier origin of Canoe River its volume changes rapidly with the temperature and amount of sunshine. During the hottest parts of the summer it is generally unfordable, but a few cloudy days so reduces the water that a passage is easily effected. At the date of our visit, in the latter part of August, it was necessary to swim the horses. Camp River, and Canoe River below the crossing, flow in opposite but parallel directions, five to six miles apart, and are separated by a high mountain ridge. The first summit on this separating ridge, called

Mount Thompson, has an altitude of 8,790 feet above sea. Viewed from Camp River this mountain presents a smooth and rounded appearance, but the opposite side is broken off suddenly by a sheer precipice of 1,500 feet with a glacier at its foot. Mount Thompson.

In order to continue the description somewhat in the order in which the explorations were carried out, it is necessary to break the thread of the narrative here, and return to the Athabasca River.

Route from Jasper Lake up Jack Creek to valley of Rocky River.

A route running S. 56° E., with the trend of the mountains, leaves the Athabasca at Jack Creek just above Jasper Lake. It was used by the Indians many years ago, when travelling between Rocky Mountain House and Jasper House. Besides affording the most direct course, it lead them through what was, at that time at least, a good hunting country. Ascending Jack Creek which is only six miles in length, the route follows the stony bed of the stream the greater part of the way. It then crosses a divide 5,600 feet above sea and further on crosses two more similar divides of 6,300 and 5,870 feet, with tributaries of Rocky River flowing northward between them. Descending from the third summit the trail reaches the outlet of a lake a mile long, which also drains northward into Rocky River. A branch route runs southward up the small stream falling into the head of this lake and through a gap leading to Medicine Lake six miles distant. The first lake mentioned is eighteen miles in a straight line from Jasper Lake. From this lake, the trail for three miles descends the stream draining it, and then turning more toward the east for a further distance of three miles, reaches Rocky River at a point distant nineteen miles from its mouth. For the latter part of this distance the trail is badly obstructed by fallen trees. Practically all the timber throughout the valley of Rocky River has been destroyed by fire, the fallen trunks now blocking and hiding the trail, which of late years has been little travelled. Crossing Rocky River the trail follows up the north bank of the stream which flows along a gravel-bottom for a distance of thirteen miles with moderate current and low banks. It is then confined between the rocky walls of a cañon a mile in length, having a fall at the upper end. The difference in level of the waters above and below the cañon is 200 feet. Four miles further up the river forks, the southern branch comes in with an elbow-like bend and its upper course is parallel to the main stream. This branch carries the greater part of the water. Valley of Rocky River.

Around the forks the valley is wider and flatter than any other part along the river. The altitude is 5,280 feet above sea. Following up Its upper part.

the stony bed of the other branch, for a distance of five miles the course is S. 80° E., then bending to S. 50° E. for a further distance of eight and a half miles, to the source of the stream in a small lake. Green timber begins shortly above the forks. It is small, however, owing to the altitude, and dies out altogether some distance below the lake.

Besides the fork mentioned there are numerous other tributaries, but none of them have any very great length, or important valleys. At the date of our visit in September their beds were for the most part dry. The whole course of Rocky River is remarkably straight, in fact it does not deviate anywhere more than a mile and a quarter from a straight line drawn from the mouth to the source. The mountains on each side of the valley, although broken into by the small lateral valleys, and varying somewhat in detail, present on the whole such a similarity of bare rocky slopes and cliffs, rising sharply at a uniform distance from the valley, that it is difficult to distinguish one part from another.

Southesk Cairn.

For some distance a conical hill is noticeable, standing directly in front, with a gap on each side between it and the bordering mountain ranges. On a near approach it is found to be a mile beyond the lake at the source of the river. This hill was named Southesk Cairn by the Earl of Southesk in 1863. The pass on the north side of it having an elevation of 7,500 feet above sea, is the lowest point on the divide between Rocky River and a branch of the Brazeau River flowing in the opposite direction.

Head-waters of Brazeau River.

The valley of the Brazeau on the other side of the summit descends rapidly, but without any cañon. The stream runs S. 60° E. for a distance of six miles, collecting the waters of several streams from the south, then turning to S. 80° E. and receiving the addition of a large branch from the south side, in a further distance of six miles it emerges from the mountains into a plateau country of between 5,000 and 6,000 feet elevation. Three miles to the east, the main branch of the Brazeau, which heads with the Athabasca near Brazeau Lake, also comes out of the mountains.

This plateau is a rich grass country, partly open, the remainder being only lightly covered with pine and spruce. It is slightly undulating, with a general slope to the north-east. The mountains rise abruptly out of this in a straight line of bare rock-cliffs, like a bold shore to a sea of green. There are no foot-hills along this part of the range, a fact accounted for by the nature of the uplift of the mountains which will be discussed in the latter part of this report.

Following a general course of N. 20° W., and gradually inclining away from the edge of the mountains the next stream of importance is nine miles distant. It is a branch of the north fork of the Brazeau. Its channel is narrow and straight with steep gravel banks 100 feet high. Two more branches of the north fork are crossed, distant three, and five and a half miles, respectively, from the first. The Forks of the Brazeau is thirty miles due east of the crossing of this last stream. The three branches of the north fork are about equal in size, being at this season (the end of September) about a foot deep and forty feet wide, but the first shows evidence of greater freshets in flood-time. Beyond the last branch the normal conditions, which usually obtain along the edge of the mountains, begin again in a long range of foot-hills having an elevation of about 7,000 feet, and running N. 60° W. with the trend of the mountains. The last branch drains the valley between this range and the mountains proper, and heads in the neighbourhood of the head of McLeod River.

Seven miles beyond this, in the same direction, a shallow stream' twenty feet wide, was reached. This was followed down six miles in a north-easterly direction and proved to be the head-waters of the Pembina River. It barely enters the foot-hills, and cannot be considered a mountain stream. Between the last branch of the Brazeau and this stream, there is a low range of burnt hills, 500 to 600 feet high, but there is a low gap between the streams just outside the long foot-hill before mentioned. Owing to the amount of erosion in the Pembina valley lower down, it seems probable that at one time some of the streams, at present draining into the Brazeau, found their way through this gap into the Pembina.

Head-waters of Pembina River

All the plateau country traversed, that drains into the Brazeau, is fairly dry and open, but, on approaching the Pembina, as the distance from the mountains has been greatly increased, the direct action of the Chinook winds is not much felt, and the effect of a greater amount of moisture is seen in the numerous swamps and muskegs. An old Indian trail runs from where the south fork of the Brazeau was left, to the last branch of the north fork, and there is divided, one branch going up that stream, and another down. The route followed from there to the Pembina, without a trail, would scarcely be practicable in any but a very dry season.

It is three miles in a north-westerly direction from where the Pembina was left, to the head of a stream flowing into the McLeod River. The watershed is formed by low hills with extensive muskegs between. The stream just mentioned was followed with a course of

Head-waters of McLeod River.

N. 40° W. for a distance of six miles, when it is diverted from the direct course to McLeod River by intervening hills, and makes a right-angled bend by turning to S. 50° W. From this bend, it is six miles to the McLeod, across hills rising about 400 feet above the McLeod. Referring to the outline formed by the McLeod River as resembling a human face, the place now reached would correspond to the top of the throat. From this point to the "Leavings," the McLeod flows on a bed of gravel and stones, with uniformly rather steep grade, but without rapids or falls. The channel is nowhere worn down to bed-rock. Frequently the river is seen running against the foot of rock banks, but it does not appear to have in any place reached the bottom of the old channel, or to be making much progress in that direction. At the place where the McLeod was first crossed below the Big Eddy, it runs on solid bed-rock.

GEOLOGY.

The rocks met with in the district covered by this report are referable to the following formations :—

Tertiary—Paskapoo beds } Laramie.
Cretaceous— { Edmonton beds } Laramie.
Cretaceous— { Pierre and Fox Hill.
Devono-Carboniferous.
Cambrian— { Castle Mt. group.
Cambrian— { Bow River series.
Archæan—Shuswap Series.

General Description.

Rocks near Edmonton.

The rocks near Edmonton belong to the Edmonton beds of the Laramie, and are well described by Mr. Tyrrell in the Annual Report for 1886, vol. II. (N.S.) p. 107 E *et seq.* They consist of black and white clay, clay-shale, coarse-grained gray sandstones, clayey sandstones, sandy shale and seams of lignitic coal. These rocks extend up the North Saskatchewan River forty miles above Edmonton, to Goose Encampment, where the top of the series is marked by two seams of lignitic coal ten feet each in thickness, separated by fourteen inches of dark clay-shale.

Drift deposits of country near Lake St. Anne.

The road from Edmonton via Lake St. Anne traverses a deeply drift-covered country, and no exposure of any formation older than glacial is to be seen. There is a great thickness of boulder-clay, nearly all the pebbles and boulders contained being gray quartzite derived from the Rocky Mountains. Boulders of Laurentian granite are numerous,

however, especially on the surface, and around Lake St. Anne boulders of yellowish-gray limestone holding Devonian fossils, and some of purplish-red quartzites or grit, are evidently derived from the Devonian area to the north and north-east.

At the crossing of the Pembina River the following section was seen :— Sections of rocks at crossing of Pembina River.

	Feet.	Inches.
Soft yellowish-gray sandstone with irregular seams of coal	12	0
Gray sandstone	1	0
Yellowish and brownish shale	9	0
Carbonaceous shale	1	0
Clay	0	6
Lignitic coal	6	0+
	29	6

These beds have a low south-westerly dip up stream. Half a mile above the crossing a seam of coal 13 feet 10 inches thick is exposed at the water's edge, overlain by four feet of impure coal. Above this is a tumbled and disturbed mass of carbonaceous shale and white clay, the result of the burning of a coal seam that lay above the one just mentioned. The clay is partly burned to a pale terra cotta. No trace of this upper seam can be seen at the present time. The fire which destroyed it burned for a number of years. The disturbance following the fire has made it difficult to trace the beds between the first section and the last, but judging by the attitude of the beds at the crossing they ought to underlie the large coal-seam of the second section. A little higher up the river on the north-west side the following section was measured :—

	Feet.	Inches.
Silty gravel	2	0
White boulder-clay	10	0
Covered	5	0
Carbonaceous shale	2	0
Lignitic coal	1	0
Clay	0	3
Lignitic coal	0	4
Impure coal	1	0
Carbonaceous shale	0	10
Lignitic coal	13	0
Covered	5	0
	40	5

In the thirteen-foot seam of coal in this section there are four small clay partings, amounting in all to nine inches. This seam is the same as that seen on the opposite side. Coal seam.

The west bank of the river at the crossing shows, at the water's edge, the same seam of coal that was seen on the east side, and is then

covered for a height of seventy feet, above which is seen fifty feet or more of thick beds of yellowish-gray sandstones. These sandstones considered alone would be assigned without much doubt to the Paskapoo beds, and when the previous sections underlying them are taken into account, the evidence seems conclusive that here is the junction between the Paskapoo and the Edmonton beds, the coal seams being on the same horizon as those at Goose Encampment.

Rocks of Lobstick River exposed in tributary.

Four miles west of the Pembina crossing, in the bed of the first small tributary of the Lobstick River, loose large slabs of yellowish sandstone are abundant, indicating the near presence of Paskapoo beds in place. Beyond this nothing is seen but the surface deposit of yellowish-white sticky clay, until two miles east of Coldwater Creek, where the northern end of a terrace-like ridge is crossed. The soil on this ridge is coarse brownish-yellow sand and seems to be locally derived from the Paskapoo sandstones that appear to underlie the greater part of the country between the Pembina and McLeod rivers.

Esker between Wolf and Moose rivers.

White clay continues to a point midway between Wolf and Moose creeks, called the Sand Hills, where a long esker commences. It is fifteen to thirty yards wide and five to fifteen feet high running N. 65° W. in a remarkably straight course, for a mile and a half, then turning to nearly due west and sending off two branches in a direction of N. 60° W. There appears to be several adjacent ridges running parallel to these branches separated only by narrow strips of muck swamp. These ridges are composed of very fine sand without any pebbles.

Limits of eastern drift.

The eastern drift extends to within two miles of the Sand Hills, or about a mile west of Wolf Creek, up to which point boulders of pink-coloured Laurentian granite are sparingly found. Beyond this point toward the west no drift was seen, except that derived from the Rocky Mountains. The boulders in this western drift are almost entirely composed of gray quartzite many of them rusty-weathering, with a few fragments of quartz-conglomerate. On a nearer approach to the mountains boulders of limestone, which apparently are not able to stand the wear and tear of long travel, begin to form an appreciable proportion of the drift.

Half a mile below the crossing of McLeod River the following section was seen :—

Section of Edmonton beds.

	Feet.	Inches.
Yellowish silty sand	3	0
Coarse yellowish-gray sandstone	50	0
Gray friable clay-shale	2	0
Carbonaceous shale	0	6
Lignite	0	6
Soft gray sandstone, some clayey bands, false-bedded	30	0
	86	0

The gray friable clay-shale contains petrified wood and fossil plants The beds are horizontal. There is nothing to be seen that would clearly show what is the age of these beds, but on account of their geographical position and the presence of soft clayey sandstones, they are doubtfully assigned to the Edmonton beds of the Laramie.

A mile above the Big Eddy on the McLeod, there is an exposure of fifteen feet of gray sandstone with nodular structure, overlain by eight feet of soft yellow and gray shales with irregular seams of lignite, the whole capped by thirty feet of yellowish boulder-clay holding small quartzite pebbles. At the upper crossing of Sun-dance Creek, five miles north-east of White Mud, ten feet of yellowish sandstones are exposed. They weather easily and show unequal hardening similar to those above the Big Eddy.

Beds near Big Eddy.

Six miles above the "Leavings" of the McLeod, an exposure on the east side of the river was seen from the opposite bank, and estimated as follows :—

Section near the "Leavings" on McLeod River.

	Feet.
Yellowish and gray sandstones with harder layers and nodules..	20
Gray shale....	5
Gray sandstone....	8
Yellowish-gray clay-shale....	6
Yellowish-gray sandstone, nodular....	10
Gray clayey sandstone with thin carbonaceous seams at top.....	7
	56

The watershed between the McLeod and Athabasca rivers is deeply covered with yellowish silty boulder-clay, having only a few small pebbles of quartzite. On the surface there are numerous large boulders of blue and gray limestone and some very large ones of quartz-conglomerate with pink coloured quartz pebbles. The latter are derived from the Cambrian rocks of the mountains, and although the nearest locality where they are found in place is fifty miles distant, the boulders are generally not much worn. Two and a half miles west of the "Leavings" a very distinct moraine occurs, running S. 5° E. and S. 50° W., in an angular form. It is composed of light-gray and rusty quartzite and quartz conglomerate, all from the mountains. Beyond the summit of the watershed a small stream has cut a channel eighty feet deep in the boulder-clay without reaching the solid rock.

Surface deposits on McLeod-Athabasca watershed.

Four miles from the Athabasca River and 650 feet above it, the surface soil becomes gravelly, indicating the presence of a body of water at some time, and across the river a long distinct terrace is visible with an elevation of 200 feet or more above this place or 4 000 feet above sea. Several lower terraces can be seen, the most extensive being 300

Terraces in valley of Athabasca River.

feet above the Athabasca. The receding waters must have remained for a long time stationary at that level, as the terrace is over a mile wide in places, and can be seen distinctly for a long distance up and down the valley.

Section on Sandstone Creek.

On Sandstone Creek, two and a half miles from the mouth, there is an exposure of hard rather coarse-grained sandstone, and near the mouth of that stream the following section was examined :—

	Feet.	Inches.
Silty soil (variable)	2	0
Boulder-clay, small pebbles	50	0
Irregular thickness of coarse yellow sand	4	0
Boulder-clay, quartzite-pebbles	20	0
Covered	8	0
Light-coloured sandstone with calcite in joints, one clayey band	6	0
Covered	10	0
Dark-gray shale	3	0
Yellowish-gray sandy shale	2	0
Sandstone	2	0
Gray shale	0	6
Gray sandstone	0	6
Carbonaceous shale	2	0
Dark-gray thin-bedded sandy shale	4	0
Covered	30	0
Gray clayey sandstone (fossils)	3	0
Yellowish-gray sandy shale, jointed	4	0
Soft gray sandstone	1	0
Sandy shale	1	6
Rather dark clay-shale	3	0
Soft shaly sandstone	4	0
Yellowish and bluish shale with irregular sandstone	5	0
Dark clay-shale	6	0
Bluish-gray clay-shale and irregular clayey sandstone	20	0
Gray sandstone false-bedded (part covered)	80	0
Bluish-gray clay-shale	4	0
Soft yellowish sandstone	4	0
	279	6

This section was not all seen in the one place, but it is believed to fairly represent the sequence of beds. Among the fossils obtained from the bed of clayey sandstone were the following :—

Physa Copei
Patula sp.
Zonites or *Conulus*
Fossil plant apparently *Taxites.*

Mr. Whiteaves who examined these, as well as the other fossils collected during the season, finds that they correspond with those found elsewhere in the lower division of the Laramie. This division of the

Laramie, called the Edmonton beds, is placed in Mr. Tyrrell's report, at the top of the Cretaceous.

Rocks of Prairie Creek.

Beyond Sandstone Creek no exposures are seen until Prairie Creek is reached, except the cut-banks of coarse gravel at streams. On the banks of that stream what looks at first sight to be a coarse pebble beach, is found to be a conglomerate composed of round quartzite pebbles, from one to three inches in diameter. The softer matrix of green sandstone having weathered away leaves nothing showing on the surface but the pebbles. To the north of this conglomerate, in a cañon half a mile in length, a section is exposed showing greenish sandstones and black shales dipping at angles of from 60° to 90°, and striking N. 65° W. At the southern end of the section the following beds are seen :—

	Feet.	Inches.
Stratified gravel and sand	4	0
Thin gray sandstones	4	0
Yellowish-gray shale, nodular, with irregular beds of greenish sandstone and two very small irregular seams of lignite	10	0
Lignite	0	4
Carbonaceous shale	2	0
Covered	3	0
Greenish sandstone	2	0
Slaty, jointed, friable shale	1	0+
	26	4

South of this section, beds of greenish sandstone and black shale alternate, the former increasing in proportion for a quarter of a mile when the rocks are almost all sandstone. Farther on the shales increase for 100 yards, but again the sandstone preponderates to the end of the exposure. The sharp folding which probably causes a repetition of some of these beds, gives the first evidence of the disturbance accompanying the uplift of the mountains.

In ascending Prairie Creek several exposures of alternating beds of greenish sandstone and conglomerate were seen, in descending order. The pebbles in the conglomerate are almost exclusively quartzite, a few only of slate were observed. The strike of these rocks is N. 65° W. the same as the last and the dip northward. In one place a dip of 60° was observed, but elsewhere it is from 20° to 30°. Beds of shale may occur here also, as the interval between exposures is considerable, and the erosion, which has been very great, would remove a greater proportion of such soft beds. Near where the route leaves Prairie Creek, the latter comes out of the hills from a lateral valley, and this may be termed the 'gap' of the stream. Opposite the gap there are no exposures, but on the hills to the north of it the same rocks are seen

dipping northward at low angles. All these rocks on Prairie Creek correspond to the Pierre shales and Fox Hill sandstones of the Cretaceous. The junction betwen them and the Edmonton beds seen at Sandstone Creek is covered. It is probably only a short distance below the mouth of Prairie Creek.

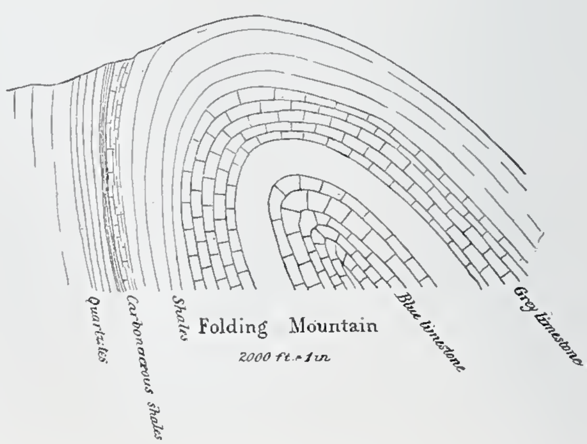
Rocks of Folding Mountain.

South of Prairie Creek, Folding Mountain, the first foot-hill of the Rockies rises, bringing up limestones, and siliceous shales and quartzites, in a sharply folded slightly overturned anticline. The following section was seen in descending order :—

	Feet.
Gray quartzites	200
Black carbonaceous shale	60
Dark flaggy limestone	100
Yellowish fine-grained siliceous shales with calcareous shales and some calcareous sandstone	500
Fine-grained gray and yellowish limestone highly siliceous, with a few bands of dark quartzite	500
Covered	300
Fine-grained blue limestone	500 +
	2160

Among the fossils obtained from these limestones are a *Syringopora* like *S. perelegans*, and another like *S. nobilis*, simple corals, brachiopods and crinoid stems. According to these the rocks could be placed in the Devonian or possibly the Carboniferous, but as Carboniferous rocks are known to have been laid down in these mountains, by the fossils collected later on, it would be necessary to assume an overthrust, far greater than there is any appearance of, in order to bring up the Devonian rocks without showing the overlying Carboniferous beds. The following figure shows the attitude of the beds in the section just given.

Fig. 1.



On the opposite side of the Athabasca, west of Brûlé Lake, in Bullrush Mountain, similar rocks have been folded in the same way, but a thrust from the south causing two lines of fracture, has as a result given a more complicated appearance. The strike of the rocks on both sides of the river is N. 65° W. The next mountain between Drystone Creek and Fiddle Creek shows a great thickness of limestone, with a fault running with the strike of the rocks, a little to the north of the summit. The plane of faulting dips to the south at a high angle. Shales appear to occupy the western flank, and some miles back from the river, along this mountain, numerous folded outliers of these rocks are seen among the limestones.

Rocks of Bullrush Mountain.

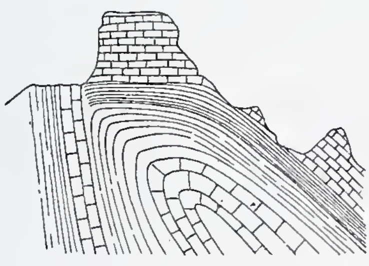
Roche Miette, a notable landmark that is prominently in view for a long distance, stands on the east side of the Athabasca a few miles below Jasper Lake. It is the abrupt termination of a range of mountains over 8,000 feet above sea. Viewed from directly in front its upper portion has a roughly cubical form with an almost vertical face of 2,000 feet. The rocks seen in this mountain are given in the following section :—

Rocks of Roche Miette.

Compact fine-grained blue and gray limestone........ ...	2000
Black shales with round nodules of iron-pyrites...............	400
Hard sandy shales............................	100
Brownish and reddish sandy shales say........................	300
Blue limestone with irregular cherty bands.........	500+
	3300

Figure (2) shows the arrangement of these beds.

Fig. 2.



Roche Miette

From the lower part of the upper limestone in this section the following fossils were collected :—

Atrypa reticularis.
Dyphyllum sp.
Cyrtina sp.
Spirifer (or *Spiriferina*) sp.
Cast of elongated spiral gasteropod.

Devonian fossils.

The age of the rocks in the above section is, according to these fossils, Devonian. All of the beds appear to be of a lower horizon than those seen in Folding Mountain. The black shales with nodules of iron-pyrites, disappear with a high dip to the south, but come to view again in a small exposure two and a half miles below the mouth of Rocky River. They are seen also on Stony River on the opposite side of the Athabasca in a series of small sharp folds.

Breaks in section.

Above Rocky River, large gaps occur in the section, caused by the deep lateral valleys, and as these valleys are generally arranged in opposite pairs, the exposures on one side do not supplement those found on the other. These breaks, and the similarity of beds of different horizons, renders it difficult to form an accurate idea of the thickness of rocks occupying this part of the valley. There appears to be a great thickness of alternating bands of blue-gray limestone and brown rather crystalline dolomites. The limestones are fine grained, and have numerous cherty bands, mostly white and irregular, but some bands of yellow chert reach a thickness of ten feet. Among the fossils contained in the limestones are the following :—

Athyris Angelica var. *occidentalis.*
Leptæna rhomboidalis.
Orthis, sp.
Aviculopecten, sp.
Pentremites, sp.
Streptelasma rectum ? Hall.
Spirifer, sp.

These are classed as probably Devonian. The dolomites are unfossiliferous. They weather out on the vertical faces to an uneven pitted surface.

Section from Snaring River to Henry House.

From a point two miles north of Snaring River, there is a section in ascending order to Henry House, with possibly a fault at Snaring River. The rocks in this section appear to overlie the last ones mentioned. At the base, comes a series of limestones, including thick beds of fine-grained bluish, light-gray cream-weathering, whitish crystalline with cherty layers, dark flaggy, white and brownish dolomitic varieties in ascending order with a total thickness of at least 5,000 feet. These are all on the north side of Snaring River, and, according to some fossils obtained, are probably Devonian. South of that stream is 800 feet of thin-bedded quartzite, yellowish-weathering dolomitic quartzite, siliceous shales and beds of gray limestone. Above these at Swift's, three miles below Henry House, is a cliff of dark-brown crystalline dolomite of medium texture. The thickness of the dolomite is about 700 feet.

Above the dolomite on the hills west of Swift's, blue and gray fine-grained limestone appears to have a thickness of 700 feet or over. The limestone was not seen continuously and possibly other beds are included here. About 500 feet above the highest part of the limestone is seen an exposure of black shales and flaggy cream-weathering limestone, from which the following fossils were obtained :—

Reticularia setigera ?
Productus, (very finely ribbed).
Spirifer, sp.
Dielasma, (cf. *D. Formosa*, Hall).

These are definitely classed as Carboniferous. Three-quarters of a mile above Henry House, the blue limestones underlying the fossiliferous beds described above, which are exposed near the river, are cut off by a fault, and no trace of any Carboniferous or Devonian rocks is found west of this point. The sudden disappearance of these beds is exactly similar to that of the Banff limestone, described by Mr. McConnell on the 51st parallel.* In both cases it 'seems to have been entirely swept away by the tremendous denudation to which the whole chain, but especially the western part, has been subjected.' Great fault.

The rock brought into contact with the limestones by the above-mentioned fault, is a hard conglomerate with pebbles seldom exceeding half an inch in diameter, and frequently so small that the rock might be called a grit. The pebbles are well rounded and consist of pinkish, milky, and semi-transparent quartz with similar pieces of greenish felspathic and chloritic rock and a little white felspar. There is a slight development of fine pale mica or talc. The rock is so typical of the Bow River conglomerates that the description of these given by Dr. Dawson in the Annual Report for 1885, vol. I. (N.S.) p. 159B, would be equally applicable in this place. Associated with these and underlying them, on the Miette River, are fine-grained conglomerates which have been squeezed out to a schist with a great development of pale mica. They weather easily, scaling off in layers along the plane of schistosity. Interbedded with these are gray and greenish-gray slates, with an abundance of small scales of mica and distinct slaty cleavage. The Miette River follows approximately the summit of a broken anticlinal fold in these rocks. These rocks have been highly altered and are now filled with a reticulation of small quartz veins, and some larger veins of two feet or more in width. For the greater part these are white and barren, but in places the cavities in the weathered surfaces show that they contain a good deal of iron-pyrites. Some claims have Bow River series. Quartz veins.

* Annual Report, Geol. Surv. Can., vol. II. (N.S.)1886, p. 19 D.

been staked out and a certain amount of work has been done. Assays of eight dollars to the ton are reported. Higher up the Miette, above Dominion prairie, 'colours' of gold can be obtained in the gravels. Its origin is probably in these rocks. Underlying the rocks just described is a great thickness of argillites, varying in colour from dark-gray to black, associated with some dark thin-bedded calcareous sandstones. The latter are considerably altered, and show an abundance of mica scales throughout. They were not, however, observed to cleave in any direction but parallel to the bedding. These rocks are also referable to the Bow River series, and correspond closely with the lower part of it. They also resemble the rock of the Nisconlith series of the southern part of British Columbia, which are of the same age.

Gold in gravels.

Rocks of Castle Mountain group in upper part of Yellow Head Mountain.

Above the highest part of the Bow River conglomerates seen in Yellow Head Mountain, no exposures were seen for a height of 1,400 feet. There is then exposed 200 feet of flat lying beds of rusty-weathering light-gray crystalline dolomite, overlain by 1,400 feet of light-gray crystalline dolomite, overlain again by 1,400 feet of gray quartzites to the top of the mountain. Both the dolomites and quartzites occur in thick beds, and the latter is of very fine texture. These beds may belong to the horizon of the Castle Mountain group of Mr. McConnell's section, or possibly to the upper part of the Bow River series. They are, however, always distinctly separable from the other rocks of the last-named series. The mountains on the south side of the pass show the same arrangement of rocks, the rusty band of dolomites toward the base being capped by the darker quartzites.

Between Grant Brook and Moose River.

The Fraser River appears to run the greater part of the way to Tête Jaune Cache on rocks of the same horizon as the Bow River series, and to have cut its valley along an anticlinal fold of these rocks. The south side of the valley was not examined owing to the unfordable character of the river, but the rocks appear to have a low dip toward the south. On the north side exposures near the bottom of the valley are very rare. A mountain on the north side between Grant Brook and Moose River, gave no exposures for the first 2,000 feet above the river, then gray quartzites were exposed dipping N. 25° E. at an angle of 70°. They are in beds two to three feet thick, with slaty partings, and continued for a thickness of 2,000 feet. Then comes a thickness of 1,200 feet of limestones and slates. The limestones include thin-bedded dark-blue, pinkish crystalline, and cream-coloured crystalline varieties. Above these is 1,200 feet of gray quartzites, with slaty partings very like the first ones seen. Overlying the quartzites is 3,000 feet of limestones and yellow schists. The

limestones are mostly flaggy, dark-blue and yellowish-weathering, and alternate with banded gray and yellowish sericitic schist. The rocks of this section correspond well with those of the Castle Mountain group. The quartzites at the bottom, which are undoubtedly the same horizon as those seen in Yellow Head Mountain, appear here to belong to the upper, rather than the middle, division of the Cambrian.

Rocks on Grant Brook.

An exposure near the mouth of Grant Brook shows disturbed and crumbling, greenish chloritic schists, striking N. 75° W. with the dip of schistosity toward the south, varying from 30° to 90°, and the dip of bedding, as seen in one place, 30° to the north. The schist weathers easily to a greenish clay, and is in places coated with ferric hydrate. Several quartz veins were seen up to a foot in thickness, showing slight signs of iron and containing some pearl spar. One of the specimens showed a coating of alunogen. The isolated nature of the exposure leaves uncertainty as to the age of the beds.

Rocks near Moose River.

Near the crossing of Moose River, bluish-gray and white, rather crystalline limestones are exposed, and a few miles below this, massive beds of gray quartzites are followed by squeezed talcose schist and hard, banded, yellowish and gray, thin-bedded schists, which are exposed near the head of Moose Lake. The strike of all these exposures is N. 65° W. and the dip varies from vertical to 70° to the north.

Rocks of Rainbow Mountains.

A mile and a half below the outlet of Moose Lake, the slope of Rainbow Mountains, although not affording a continuous section, shows near the bottom a considerable thickness of black and gray argillites, followed by gray quartzite and smooth greenish slate, and beyond this, after a wide break in the section, a thickness of at least 500 feet of quartzite, followed by 1,200 feet of black argillite, to the summit. The quartzites are coarser grained than any previously met with, and contain sufficient iron to weather out to brilliant red colours. Quartz veins are numerous in the argillites at both the top and bottom of the mountain. To the north of the summit, across a valley, thick beds of dark-coloured rock are seen, overlain by dark and yellow banded rocks looking like those seen on the mountain between Grant Brook and Moose River. The appearance of these rocks beyond the summit, makes it seem probable that those seen on the slope of the mountain, are of middle Cambrian age, the coarser quartzites perhaps representing the conglomerates seen elsewhere in that series.

Between Moose Lake and the Grand Fork of the Fraser River, several exposures were seen of black argillites and light-gray schists containing crystals of iron-pyrites. In the cañon north of the Grand Fork

these are interbedded with dark flaggy limestone. The strike continues about the same, N. 65° W., with a dip of 50° to 70° to the north.

Character of rocks between Grand Fork and Swift Current River.

The mountain between Grand Fork and Swiftcurrent River is composed of greenish and gray schists, with fine-grained schistose conglomerate near the bottom, the latter in beds six feet thick. Toward the summit there are black argillites in great thickness, with thick beds of gray talcose schist, dark flaggy limestone and slightly schistose conglomerate. Specimen No. 86 from the top of this mountain was taken from a part of the conglomerate where the pebbles are smaller than usual. A slide cut from this specimen has been examined by Dr. Barlow who gives the following description of it:—

Description by Dr. Barlow.

'Under the microscope the rock is seen to be a rather typical arkose or quartzite-grit. It is composed of comparatively large individuals of rounded or sub-angular grains, chiefly of quartz, with a much smaller proportional amount of orthoclase and plagioclase. These are embedded in a ground-mass much smaller relatively in quantity, made up of smaller fragments of these minerals together with a large amount of pale-yellowish sericite in minute irregular scales, most of which, at least, has resulted from the decomposition of both the orthoclase and plagioclase. Irregular patches of hydrous iron-oxide, which have evidently been derived from the decomposition of some ferruginous carbonate, are rather abundant. Occasional fragments and crystals of zircon were also noted. The quartz is of the usual granitic varieties, with dust-like and other inclusions. Some of the quartz shows undulous extinction very beautifully, as a result of pressure. Both plagioclase and orthoclase show considerable alteration to sericite.' The base of Robson Peak is probably composed of rocks similar to those last described, while the upper portion appears to consist of banded black and yellowish limestone and yellow schists, resembling those seen between Grant Brook and Moose River. The strongly marked horizontal lines on the face of the mountain are due to the unequal weathering of these rocks. If the fine-grained quartzites continue this far westward, they should appear between these two series.

Strike of rocks below Moose Lake.

As far down as the Grand Fork, the Fraser follows the strike of the rocks along an anticlinal fold, the rocks on the south side dipping away from the valley at low angles while the dips on the north are much steeper in the opposite direction. On the south-western stretch of the river from Grand Fork to within four miles of Tête Jaune Cache, it cuts across the strike almost at right angles, exposing a great thickness of highly altered schistose rocks that appear in all cases to have

been originally arkose. The lowest rocks in the series are seen about Swift-current River. Below that point there is an anticline followed by an ascending series for four miles, and then a synclinal fold bringing up the beds again, so that those seen at Tête Jaune Cache are not very far above the horizon of the beds at Swift-current River.

Specimen No. 90, from a point two miles above the Cache, and No. 91 from the south bank of the Fraser at the Cache, have been examined by Dr. Barlow, who gives the following description of them :— Description of rocks from near Tête Jaune Cache.

'No. 90 is an arkose, which has been subjected to pronounced dynamic action. The larger quartz and felspar individuals may still be detected, but a marked foliation or schistosity has been induced in the rock as a result of pressure, the cleavage-planes being coated with silvery scales of hydrous muscovite or sericite. It has undergone advanced recrystallization, so as to mask its original character, and under the microscope presents a mass of interlocking grains of quartz orthoclase and plagioclase in which may still be detected the remains of larger individuals of the same minerals. Biotite is quite abundant and in a lesser amount sericite. Zircon is also present. The rock has been subjected to such a degree of pressure that the larger individuals are often broken up into a fine mosaic of interlocking grains. Some have not yielded completely, but are very badly shattered, while the individuals, which are as yet unbroken, show very pronounced strain shadows.

'No. 91 is very like No. 90, and has also been subjected to pronounced pressure with recrystallization. It contains a considerable amount of hydrous iron-oxide running with the foliation, which seems also to have been derived from the decomposition of some iron-bearing carbonate. Its clastic structure is masked somewhat by the recrystallization, but taken in conjunction with the preceding specimen its clastic character seems undoubted. Sericite is not so abundant. Occasional crystalline fragments of brown strongly pleochroic tourmaline was noticed as also fragments of apatite.'

Contrary to the changing dips of bedding, the dip of schistosity in these beds is constantly to the south at angles of 50° to 70°. Near Tête Jaune Cache, where some minor folds in the rocks were seen, the planes of cleavage cut across the curved lines of bedding like the vertical lines in the sign used to designate dollars ($). Cleavage cutting across bedding.

These rocks are of Cambrian age, and probably belong to the same horizon as the Bow River series.

Rocks of mountains on east side of valley of McLennan River.

Eight miles south-east from the Cache, the mountains on the north-east side of the valley show at the bottom 4,000 feet or more of hard schistose conglomerate with pebbles of semi-transparent bluish quartz and milky-white felspar, dipping N. 25° E., at an angle of 30°. Above these is a thickness of 2,500 feet consisting of, banded gray and yellowish sericitic schist with patches of a black iron-mica probably biotite, and some crystals of iron-pyrites, a coarser grained sericite schist (Specimen No. 97) including beds of thinly-laminated broadly-cleavable sericite-schist and dark flaggy limestone.

Specimen No. 97 is described by Dr. Barlow as follows :—

'No. 97, a sericitic schist. It is a quartz-felspathic sandstone which has been altered as a result of pressure and recrystallization. It is now an interlocking aggregate of quartz, orthoclase and plagioclase, in somewhat uniform grains whose longer axes correspond with the marked foliation of the rock. Sericite and chlorite are likewise present in considerable amount in small irregular scales, running with the foliation. A ferruginous carbonate, most of which is decomposed to hydrous iron-oxide, is also abundant. Tourmaline in brown strongly pleochroic fragments is also rather plentiful, while some individuals of zircon were noted.'

Quartz veins.

These rocks occupy the upper portion of the first mountain in the form of a low syncline. They are all highly altered, the planes of schistosity running N. 65° W. and dipping toward the south at a high angle. A series of secondary cleavage or jointage planes run N. 25° E. vertical. Quartz veins are very numerous in these rocks, fifteen were counted in less than a mile. They vary from one to five feet in thickness and run with the secondary cleavage. All of them show more or less decomposed iron. Assays of some specimens did not show any mineral of value.

Another system of quartz veins is developed parallel to the principal cleavage-planes. None of these were seen of a greater thickness than one foot, and they do not seem to have the same persistence as the larger veins. Specimens were collected showing a small percentage of galena which proved to be argentiferous.

Argentiferous galena.

Just beyond the summit of the first mountain, and three and a half miles north-east from the main valley, there is an anticlinal fold of highly quartzose schists. These are only exposed for a short distance when their dip carries them out of sight, but they reappear two miles farther to the north-east, on the summit of the next ridge. On this ridge the quartzose schist gradually merges into hard conglomerate

holding pebbles of quartz and felspar and some larger fragments of black argillite. A specimen (No. 101) of the finer-grained portion of this rock was examined by Dr. Barlow, who gives the following description of it :—

'No. 101 is a light-gray sandstone, very similar to No. 86 (p. 34D) only less massive, while it contains abundantly disseminated small crystalline fragments of a ferruginous carbonate. Under the microscope its clastic structure is undoubted. It is composed of comparatively large individuals of quartz, orthoclase, plagioclase and microcline in a cement made up of the same minerals in a finer state of division, together with a considerable amount of minute irregular scales of sericite. The ferruginous carbonate mentioned above, shows characteristic high relief and brilliant polarization, and marked pleochroism almost colourless to pale-brownish, this property being most pronounced in the darker coloured individuals. Incipient alteration to yellowish iron-oxide may be noticed. It occurs in irregular crystalline aggregates with rhombohedral cleavage, occasional scales of biotite were noticed, as also some rather large crystals of zircon.'

The quartzose schist before mentioned as associated with this rock contains some crystals of iron-pyrites and pale-red garnet. The intervening low synclinal trough between the two ridges is occupied by rocks similar to those near the top of the first mountain. They have been here even more altered than in the first place, and consist chiefly of shiny lead-gray wrinkled sericite-schist and fifty feet of cream-coloured crystalline limestone.

Rocks of mountains east of Cranberry Lake.

The mountains east of Cranberry Lake show the same general sequence of beds as the first mountain. At the bottom there are yellowish-weathering coarse glittering schists with some large pebbles of quartz. These are evidently highly altered squeezed conglomerates. Dr. Barlow makes the following statement about a specimen collected here :—

'No. 100 is a rusty-weathering quartz-felspathic schist. It has undergone much deformation as a result of pressure, and its original grains have been greatly rolled out and granulated. The clastic nature of the rock is quite apparent despite the metamorphism. Sericite is present, though not very abundant, and is confined chiefly to the planes of cleavage as it has resulted from the shearing of the felspar. Iron-oxide is abundant, and has resulted from the decomposition of an iron-bearing carbonate. The rock is composed chiefly of quartz with a smaller amount of orthoclase and plagioclase.'

Above these beds are gray talcose schists wrinkled and squeezed, with a great thickness of gray and black argillite also wrinkled, and talcose between the layers. The top of the mountain is composed of hard gray schist, highly micaceous. In all these rocks above the altered conglomerates there are veins of quartz, slightly rusty. An adjacent mountain to the south-east, near the top is composed of black argillites, lead-gray sericite-schist and dark flaggy limestone. The argillites are rusty and micaceous. Several veins of rusty quartz were noted.

Traces of gold

Colours of gold can be found in most of the streams on the north-east side of the valley, and it is also reported that gold can be found in tributaries of the Fraser River.

Horizon of rocks of western slope of Selwyn Range.

The rocks just described on the north-east side of the valley between Tête Jaune Cache and Canoe River, are undoubtedly of Cambrian age. The squeezed conglomerate of the lower part of the series may be without much hesitation assigned to the horizon of the Bow River series, while the overlying schists and argillites probably belong to the same series but may include, toward the top, beds of the upper division of the Cambrian or Castle Mountain group.

Throughout the district so far described, the rocks are all stratified and no granite or other plutonic rocks were seen. It is safe to say that none such exist anywhere in the vicinity of the route traversed. Neither were any rocks of Archæan age met with, although gneiss was reported by Sir James Hector to occur on the Athabasca near the mouth of the Miette River. The fine-grained schistose conglomerate existing there, was probably mistaken for gneiss in the hurried examination made while travelling in the winter.

Archæan rocks of Mica Mountain.

On the south-west side of the valley, opposite Tête Jaune Cache, on Mica Mountain a great series of mica-schists are found dipping S. 45° W. at angles of 30° to 50°. This series includes dark glittering mica-schist, easily weathering, thinly foliated garnetiferous mica-schist, with a high percentage of mica and garnet, hard garnetiferous mica-schist in massive beds, bands of dark fine-grained micaceous rock apparently of eruptive origin, and layers of fine-grained gneiss which in some instances at least, is certainly intrusive. The whole series while differing somewhat from the Shuswap series of the southern interior of British Columbia, shows the main characteristics of that series and may be classed as such. The age of this series as given by Dr. Dawson is Archæan. The wide valley intervening between these rocks and those of Cambrian age opposite, is covered by superficial deposits and hides the line of contact. It would be necessary to

assume a great fault along this valley to explain the altitude of the rocks of the Shuswap series, if the apparent dip of these rocks were the real dip of the original bedding, but such is not the case. The rocks are extremely foliated and all trace of the original bedding is destroyed. This foliation is roughly parallel to that seen in the Cambrian rocks across the valley where the original bedding could still be distinguished. As it was there entirely independent of the dip of the bedding, it cannot here be taken to have any significance in the determination of the thickness of the formation.

Correlated with Shuswap series.

Pegmatite veins are of frequent occurrence in the garnetiferous mica-schists, some of them having a thickness of over fifty feet.

Constituents of veins at Bonanza mica mine.

The ordinary constituents of these are, quartz, triclinic felspar and muscovite. In addition to these they sometimes contain tourmaline, garnet, cyanite, beryl and apatite. Dr. Hoffmann has kindly examined many of the mineral specimens collected, and has determined these. On one of these veins, seven miles south of Tête Jaune Cache, the Bonanza mica mine is located. It is 5,300 feet above the level of the Fraser River. Where an opening has been made, the veins is about fifteen feet wide dipping S. 45° W. < 40°, with the schists. Its continuation to the north-west is covered with talus from the mountain, while on the south-east side of the opening, the original rounded top of the vein is covered by the schists. The quartz, felspar and muscovite are separated into large masses. The crystals of muscovite, which are frequently eighteen inches long and eleven inches wide, are found in greatest abundance near the hanging wall. It is evident, not only from the fact that the great denudation to which these mountains have been subjected has only in recent times exposed the top of the deposit, but also from the amount of segregation, that the mass has been cooled at a great depth, and very slowly. Beryl is found in this vein. The mica is a transparent muscovite with a very slight greenish cast, and of excellent quality. While little work has been done with a view to proving the extent of the deposit, it may reasonably be expected, from what actually appears, that a large quantity of mica can be obtained here, and the probabilities of further important developments appear to be very favourable. Thirty feet below the Bonanza vein, is another vein of pegmatite, forty feet thick. A few miles to the south-east across an intervening ridge, another claim has been located by some Edmonton miners, but no work was in progress and the place was not visited.

Ten miles in a straight line to the south-east, the mountains near the head waters of Canoe River, are composed of the same rocks as

Mica Mountain, the garnetiferous mica-schist being here also the predominating rock. Pegmatite veins also occur and several mica claims have been staked out. On one of these some work is reported to have been done, exposing a deposit of marketable mica.

Rocks of Mount Thompson.

Mount Thompson between Camp River and Canoe River is also composed of rocks of the Shuswap series. They differ somewhat from those previously described by having a greater proportion of gray gneissic layers and highly quartzose glittering mica-schist. The gneissic layers in general follow the foliation of the schists, but are occasionally seen to break through them. They appear to have been originally intrusive granitoid rocks. There is no indication of gold in the rocks on this south-western side of the main valley.

The continuation of the valley to the north-west and south-east, seems to coincide with the dividing line between the Archæan and Cambrian rocks.

Devonian rocks of Rocky River.

Returning to Jack Creek on the Athabasca River, to keep the same order of precedence as in the descriptive part of the report, the exploration via Rocky River will be taken up. The route followed was almost directly along the strike of the rocks, and hence the observations made did not add much to the information already obtained about the rocks, except in regard to their geographical extent. The rocks along the whole route from the Athabasca to the Gap of the Brazeau, appear to be of Devonian age. They consist of brown dolomite and fine-grained gray limestone, with some thin beds of gray and brownish sandstone and shale. On the lower part of Rocky River the rocks have sharp folds and steep dips, but at the summit of the pass to Brazeau River they are only gently inclined to the south-west. This attitude is maintained to the edge of the mountains, in direct contrast to what was seen at the edge of the mountains on the Athabasca. On the Brazeau the transition from the mountains to the level plains is abrupt. No folding or crushing is to be seen, but a straight uplift without contortion of the beds and apparently without overthrust, for although the talus from the limestones hides the line of contact with the Cretaceous rocks of the level country beyond, these rocks are both found in place in the bed of the stream in positions which seem to preclude the possibility of a lateral movement of any extent.

Uplift of mountains without overthrust near source of Brazeau River.

Cretaceous rocks of Brazeau Hills.

The Cretaceous rocks referred to are greenish-gray sandstones, in beds three feet thick, with thin layers of conglomerate composed of small round pebbles. They dip to the north at a low angle, showing very little signs of disturbance. These rocks are identical with those

found on Prairie Creek, and appear to occupy, without any disturbance, the level country between the base of the mountains and the Brazeau Hills. The Brazeau Hills have an elevation of 6,500 or perhaps 7,000 feet above sea, and run parallel to the edge of the mountains, at a distance of ten or fifteen miles therefrom. The Brazeau River escapes through these by a very narrow deep cañon.

Northward from the Gap of that branch of the Brazeau just described, the same rocks appear to continue for some distance, though only one exposure of a finer-grained variety of sandstone was seen. Thirteen miles distant in a straight line, on a stream flowing north-eastward to the north branch of the Brazeau, there is an exposure of 150 feet of beds consisting of carbonaceous shale and yellowish sandstone with numerous small seams of coal, one of which has a thickness of three feet. The dip of these beds is N. 45° E. < 60° and a mile beyond the last branch of the Brazeau, greenish sandstones were found dipping S. 60° W. < 60°, thus showing that only for a short distance along the edge of the mountains the rocks escaped the usual lateral pressure accompanying the uplift.

Cretaceous rocks of head-waters of Pembina River.

The first rocks met with on the Pembina River were dull olive-green sandstones and shales striking N. 65° W., vertical. Farther down the river the rock consists entirely of soft gray shales, containing rounded and lenticular nodules of gray ironstone, sometimes cherty. As the river is descended the dips become undulating and less, until, at a distance of nine miles from where the river was first reached, the beds are almost horizontal. These rocks, as well as the shales and sandstones near the last branch of the Brazeau, closely correspond with the Pierre division of the Cretaceous.

Edmonton beds exposed along the McLeod River.

Along the McLeod River, from where it was reached to the 'Leavings,' numerous separate exposures were seen showing chiefly irregular coarse yellowish sandstone and clayey false-bedded sandstone. Interbedded with these are carbonaceous shales, and one seam of coal a foot thick was seen. Other seams were reported to occur on the river. Some prospecting has been done on the McLeod, in which a certain quantity of gold was obtained. It is found chiefly in a small seam in the river-gravels, principally composed of dark material derived from the shales. No fossils were found in these rocks to determine their age, but stratigraphically they appear to belong to the Edmonton beds or lower division of the Laramie.

Superficial Deposits and Glaciation in the Mountainous Region.

Evidence of former glacier in valley of Athabasca River.

The valley of the Athabasca has contained a large glacier flowing northward down the stream. No striæ were observed, as the limestones are not suitable to their preservation, but the rounded appearance on the southern side of projecting rocks shows the action of the ice and the direction of its flow. Boulder-clay is to be seen in many of the lateral valleys It is chiefly composed of local material, but also contains boulders that have travelled at least thirty miles. The boulders seldom exceed six inches in diameter, and are generally without any appearance of stratification.

Post-glacial lakes in valley.

After the disappearance of the glacier, the valley appears to have been occupied by a body of water standing at a level of 550 to 600 feet above the level of Jasper Lake. A long distinct terrace on the west side of Jasper Lake marks this level. It is composed chiefly of gray silt with a varying proportion of sand, and in some parts a few pebbles of quartzite and limestone. The fine silty sand along the shore of the lake and the banks of the river is probably derived from the washing down of this terrace.

Terraces near Henry House.

Above Henry House on the west side of the river, a well marked terrace 600 feet above the river, is composed of white calcareous silt containing pebbles of quartzite firmly cemented together. In one place the front of the terrace weathers out into conical pillars. These are without the usual large boulder forming caps, as none of the pebbles are of more than six inches in diameter. Terraces on the opposite side of the river are noticeable at about the same level. Along the upper part of the Fraser River valley a white silt terrace is seen in several places, and is best defined for some distance above Moose Lake. Its elevation is 3900 feet above sea, which is about the same as terraces just mentioned on the Athabasca. Along the Miette valley and the Yellow Head Pass between this place and the Athabasca River, there are some signs of a terrace at about the same level, but not very distinct. This terrace as well as the typical white silt dies out near Moose River. It would appear that part of the Athabasca valley and this upper portion of the Fraser valley were occupied by one continuous body of water, in which the white mud derived from glaciers was deposited. A possible explanation of the termination of the white silt, is that the glacier coming in by the valley of Moose River, completely blocked the Fraser valley, holding back the waters for a long period of time. Along the remainder of the Fraser River to Tête Jaune Cache, while silty material is to

Former lake in Yellow Head Pass.

be seen locally, as well as clay, but the greater part of the superficial deposit is coarse stony gravel. In the valley between Tête Jaune Cache and Canoe River, on the north-east side near the base of the mountains, there are rolling ridges of fine sand for a distance of four or five miles from the Cache. The sand is washed very clean and will scarcely support any vegetable growth. That it contains a certain amount of iron is noticeable where recent fires have given it a bright red colour. A few miles further on, the cut-bank of a stream shows this sand to be well stratified. This valley has also been occupied by a body of water, and terraces were noted in two places having an elevation of 1,000 feet above the Fraser River at the Cache, or 3,400 feet above sea-level. The most extensive and best marked terrace in the valley is that on the south-west side of Canoe River opposite the crossing. Its elevation is 2,950 feet above sea.

Glacial striæ

No glacial striæ were seen on any of the higher mountains, and from their sharply angular appearance it does not seem probable that they were ever overflowed by ice. A mountain 8,000 feet high, situated eight miles, S. 60° E. from Tête Jaune Cache, showed signs of heavy glaciation, the striæ running S. 25° W. Robson Peak, lying in the direction from which this ice came, has probably been a gathering ground discharging south-west into the great valley. Mt. Thompson having an elevation of 8,790 feet has the general smooth aspect of a glaciated summit, but no striæ, nor travelled boulders could be found.

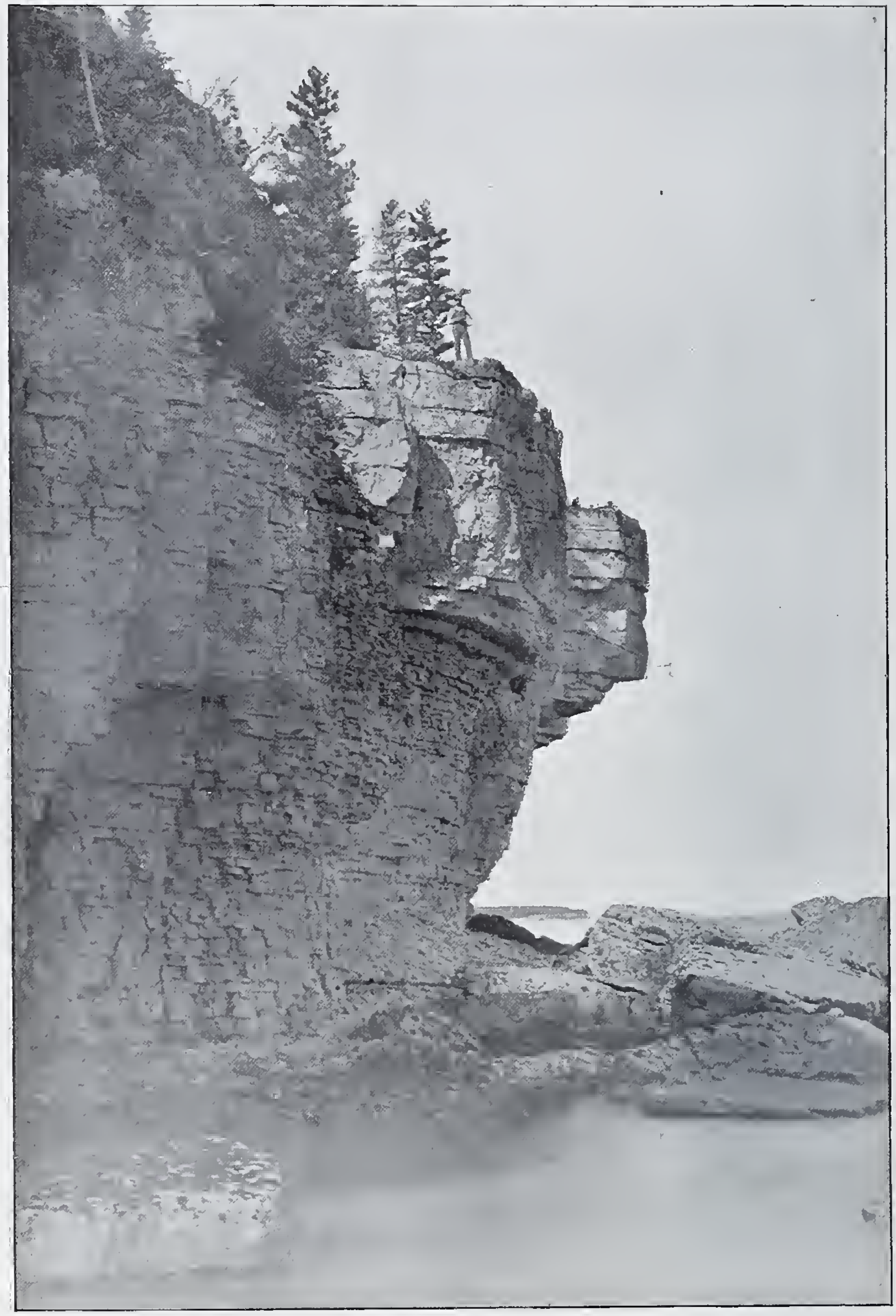
Trees.

The distribution of the principal trees is given in the following short notes :—Black and white spruce (*Picea nigra* and *P. alba*), poplar and cottonwood (*Populus tremuloides* and *P. balsamifera*) are found generally throughout the whole country traversed. Larch (*Larix Americana*) extends as far westward as the McLeod River and ascends that stream forty miles above the 'Leavings.' It was not seen on the Athabasca or westward. Black pine (*Pinus Murrayana*) first seen thirty miles west of Edmonton, continues throughout. Douglas fir (*Pseudotsuga Douglasii*) commences three miles below Jasper house and continues westward. The eastern 'balsam' (*Abies balsamea*) was first seen on the Athabasca River, while *A. subalpina* was found generally throughout the mountains. White pine (*P. monticola*) was seen at Moose Lake on the Fraser River. White-stemmed pine (*P. albicaulis*) was on most of the high mountains. Cedar (*Thuya gigantea*) and Hemlock (*Tsuga Mertensiana*) came in a few miles below Moose Lake and continue westward. Yew (*Taxus brevifolia*) is found on wet mountain sides, on the Fraser and Canoe rivers. Engelmann's spruce (*Picea Engelmanii*) was found generally through-

out the mountains, and another form seen is probably that noted by Prof. Macoun, as intermediate between this and the white spruce. Lyall's larch (*Larix Lyallii*) does not occur in the mountains in this district. Canoe-birch (*Betula papyrifera*) was first seen on the Athabasca River and continues westward.

Game

The occurrence of game in the district is summarized in the following notes :—Elk, sparingly found in the foot-hills of the mountains. Moose and deer, throughout, rather scarce. Caribou, in the mountains, scarce. Mountain sheep, scarce in the first ranges of the mountains. They do not appear to go more than thirty or forty miles into the mountains and seem to confine themselves to the limestone ranges. Mountain goats, plentiful, especially far into the mountains. They prefer higher and more rugged mountains than the sheep. Grizzly and black bears plentiful, the former in the mountains, the latter throughout. Grouse fairly abundant. Fur-bearing animals are to be found, but are not very plentiful now on account of the burning of the forests.



D. B. Dowling, Photo.

CAT HEAD—LAKE WINNIPEG.

GEOLOGICAL SURVEY OF CANADA

G. M. DAWSON, C.M.G., LL.D., F.R.S., Director

REPORT

ON THE

GEOLOGY OF THE WEST SHORE AND ISLANDS

OF

LAKE WINNIPEG

BY

D B. DOWLING, B.A.Sc.

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST
EXCELLENT MAJESTY
1900

704.

To G. M. Dawson, C.M.G., LL.D., F.R.S.,
Director Geological Survey of Canada.

Sir,—I beg to submit the accompanying report on the west shore and islands of Lake Winnipeg. In order to complete the descriptions of occurrences of all the formations in this district, extracts are taken from Mr. J. B. Tyrrell's notes. To illustrate some of the structural features sketches and sections are also submitted.

I have the honour to be, Sir,
Your obedient servant,

D. B. DOWLING.

January, 1899.

NOTE.—*The bearings in this report are all referred to the true meridian*

REPORT

ON THE

GEOLOGY OF THE WEST SHORE AND ISLANDS OF LAKE WINNIPEG

By D. B. Dowling.

General Description.

The basin in which Lake Winnipeg lies is very long and rather shallow, divided by narrows into two parts, the major portion being that to the north. The lake ranks fifth in superficial area among the lakes of North America. Its area of 9,414 square miles is 2,150 square miles more than that of Lake Ontario, and but 500 square miles less than that of Lake Erie. Its greatest length is 260 miles, somewhat longer than Lake Erie, or about the distance from Ottawa to Hamilton, Ont. For the sake of comparison it may be interesting to note that this is also nearly the length of the peninsula of Nova Scotia from the Strait of Canso to Yarmouth or only twenty miles less than the length of Vancouver Island. In width the lake varies very much, as a reference to the accompanying map will show, but its maximum, in the northern part, is about sixty-six miles. It has a mean height above the sea of 710 feet, and a general depth of from 40 to 60 feet. The fact that the lake is so shallow is no doubt mainly due to the shape of the rocky basin in which it lies, but it has been still further reduced by the amount of silt deposited already by its waters. This lake is the principal settling basin at present for the waters of streams draining from the Rocky Mountains, as well as those coming from the south by the valley of the Red River, and the streams from the eastern side from the height-of-land to Lake Superior.

Area of lake.

Dimensions

Depth.

On the east side, the principal streams entering the lake are :—The Winnipeg River, the Berens River, the Pigeon, Poplar, Manigotagan and several smaller streams. These flow from the country underlain by the Archæan.

Streams entering.

On the south, the continuation of the depression in which the southern portion of the lake lies is that down which the Red River drains, bringing with it the waters of the Assiniboine, Pembina and other tributaries. On the west, the greatest stream entering the basin is the Saskatchewan. This large river literally falls into Lake Winnipeg, as in the last four miles of its course the descent is 70 feet, forming the Grand Rapids. The Dauphin or Little Saskatchewan River drains into Sturgeon Bay and brings the surplus from Lakes Manitoba and Winnipegosis.

Other small streams such as War-path River, Fisher River and Icelandic River may be mentioned, but they drain only limited areas.

Geological Features.

Formation of basin.

The basin of Lake Winnipeg is excavated along the contact of the Palæozoic limestones with the Archæan which forms so large a part of the middle northern part of the continent. Here the surface of the Archæan forms a gently sloping plain trending to the south-west, on which was laid down a very sandy deposit, first formed when the sea was advancing, followed by a succession of limestone beds. The thinner overlapping deposits have now been removed from the Archæan, and the process of denudation has been no doubt greatly assisted by the scouring action of the glaciers, until what was, perhaps, previous to glacial times, an escarpment along the foot of which ran a stream passing probably through several small lakes, is now a large basin occupied by the lake, on the western side of which are found the cliffs of limestone that are the remains of beds that formerly extended north-eastward to join those of the Hudson Bay basin. The rocks of the east shore are all gneisses, granites, schists, &c., of the Laurentian and Huronian formations, and the country is naturally more rocky and barren than that to the west and south, which is well covered by till or boulder-clay and later lacustral deposits. From Lake Winnipeg eastward, there is, partly covering the rough rocky country, a deposit of stratified clay and silt which has been carried to a height of about one hundred and fifty feet above the present lake during one of its higher stages, while still ice-dammed to the east. The silt deposited in this way was derived from the material brought by the glacier and is found to extend northward past the limits of the map, affording farming land in unexpected quarters where only rocky hummocks would otherwise be looked for. In this connection the following paragraph by J. B. Tyrrell may be quoted :—

Lacustral deposit of east side.

'A deposit of clay similar to that on Mossy Point extends all along the east shore of Lake Winnipeg, and the waves dashing against the soft cliffs become charged with the mud, from which the lake derives its name. This clay is also of great economic interest, for instead of the east shore of the lake being an uninhabitable rocky wilderness, as is generally supposed, it is largely covered with a rich, blue alluvial soil, and the area of rock surface is relatively small. Much of this land is covered with forests of poplar and spruce, while on account of the retentive impervious nature of the clay soil much of it is also boggy and wet, but when it is cleared and drained it will form rich agricultural lands. At Badthroat River, Mr. Wood, the local Inspector of Fisheries, had cleared a beautiful farm out of the midst of the poplar forest, and he informs me that he grows successfully all the crops ordinarily raised in Ontario. Mr. McKay, the Indian Agent at Berens River, has also a clearing situated on the south side of the river in the midst of what was a dense forest of small spruce. He has under cultivation a nice garden, and this year the potatoes were not cut down by the frost till the middle of September.'* Agricultural land.

On the south side, the limestones are generally deeply covered by a mantle of boulder-clay. The lacustral deposits of the glacial Lake Agassiz are thinner here than to the south. Those along the east side, near the Winnipeg River, are sandy, and the rich, black alluvium of the valley of the Red River is confined to narrow limits. Those near the lake are generally later river deposits brought down by the present stream. Soil of south side.

Along the west shore, the rock exposures show sandstones capped by Trenton limestones, and many picturesque headlands rise in steep cliffs of a light-yellowish and whitish limestone lying in horizontal beds. The surface of the country behind is of a general level aspect, rising slightly. Over all this is a mantle of boulder-clay, mostly of a reassorted character, showing faint lines of stratification as though deposited in a body of water. Traces of underlying drift deposits which have been overridden by the glacier are occasionally suggested by the form of some of the smaller low-lying islands near the west shore whose contour and outline have the aspect of drumlins. The surface is generally well wooded with aspen (*Populus tremuloides*) and black and white spruce (*Picea nigra* and *P. alba*). Rocks and soil of west shore.

The principal settlements are those of the Icelandic colonies on the west side of the southern portion of the lake, those of the Indians and

* Annual Report, Geol. Surv. Can., vol. V. (N.S.) 1890, p. 32 A.

half-breeds on the lower part of the Red River and scattered settlements on the east side, principally between the Red River and Fort Alexander. The accompanying map also shows in its southerly part the more thickly populated country in the vicinity of the railway lines.

General Resources.

Fishing industry.

Fishing.—The waters of the lakes in the basin are generally well stocked with a large variety of the fresh-water food fishes, but the abundance of these in the waters of Lake Winnipeg has induced the establishment of extensive fisheries and the curing and shipment of large quantities of whitefish and trout. From the reports of the Inspector of Fisheries for this district the following figures are submitted.

The fish exported in the early years of the industry were whitefish, pike and pickerel, and for the years 1883 and 1884, the figures are given as follows :—

Export for 1883-84.

	1883.		1884.	
	Quantity.	Value.	Quantity.	Value.
Whitefish.........	72,867 lbs.	$ 3,041	359,000 lbs.	$ 14,036
Pike	51,850 "	1,061	561,000 "	13,855
Pickerel.........	2,400 "	480	.... "	... .
	127,117 "	$ 4,582	920,833 "	$ 27,891

These figures represent the export for the province, but as the principal fishing was in the large lakes of Manitoba, that for Lake Winnipeg must have been fully one half. This great increase in the export between the above years is probably accounted for by the formation of fishing companies that erected large ice-houses at Selkirk and Westbourne near Lake Manitoba. During the next year the increase was 100 per cent and for 1885 the figures given are as below :—

Export for 1885.

	Quality.	Value.
Whitefish	759,730 lbs.	$ 32,500
Pike.....	670,443 "	21,877
Pickerel.........................	33,515 "	1,340
Tullipee	1,600 "	80
	1,465,288 "	$ 55,797

The product of Lake Winnipeg is fully half of the total, as an estimate of the winter fishing and other shipments from Lake Manitoba

is given as :—whitefish 300,000 lbs., pike 450,000 lbs. The growth of the industry may be further studied by referring to the figures for the years 1888–89–90 during which three fishing companies were operating on Lake Winnipeg, employing many tugs and barges for the conveyance of frozen fish to the cold-storage warehouse in Selkirk. The fish at that time were frozen while freshly caught, by means of salt and ice. In 1889 these companies employed about sixty miles of nets.

Value of export of fish :—

Export for 1888–1890.

1888	$180,677
1889	167,670
1890	232,104

Fish-hatchery.

The decrease in 1889 from that of 1888 is due to the decrease in the quantity of salted whitefish shipped, the industry having been altogether discontinued in favour of the frozen fish. The output of the smaller lakes was maintained at about the same figures for nearly all these years, the estimate for 1889 being about $21,000. It is thus evident that the fishing industry of Lake Winnipeg is very important. Subsequently a fish-hatchery was established at Selkirk, and as a means of self-protection from over production and possibly depletion of the lakes, the companies became amalgamated into one concern, using more modern methods in preserving and shipping. At present the cold-storage warehouse in Selkirk is equipped for the ammonia process, and several large steamers are constantly running during the fishing season to the fishing grounds, principally in the northern part of the lake, where there are branch establishments at Selkirk Island, Mossy Point and at Berens Island.

Cold-storage.

Timber.

Timber.—On the western shores there doubtless remain isolated patches of large white spruce, but many areas have been practically exhausted. Small portable mills were erected at convenient points and all the available material in the vicinity was sawn up. Then the mills would be moved to other grounds. Such points may be mentioned as Fisher River and Fisher Bay, Washow Bay and the vicinity of Dog Head, west side. On the east side of the lake, the streams operated on generally afforded sufficient water-power to run the mills, but in a few cases, steam was also used. The principal lumbering operations on the east side have been on the Bad-throat River and possibly other streams will be exploited. The best timber reported on this side is on the Gunisao River flowing into the channel between Great and Little Playgreen lakes.

From the report of the Crown Timber Agent, the following figures are given as the amount of lumber (spruce) cut at the following places:—

—	Ft. B.M.	Ft. B.M.	Ft. B.M.
	1889.	1890.	1891.
Badthroat River (two companies)	1,737,284	1,662,241	1,724,159
Fisher Bay	2,401,582	1,350,000	800,000
Ebb and Flow Bay	795,750	1,204,698	1,047,475
Washow Bay	251,553	....	....
Fisher River	1,658,232	....	....
Grindstone Point	....	98,000	....
Black Island	....	....	516,490
	6,844,401	4,314,939	4,088,124

This return shows a steady decrease and compared with that for 1884 maintains about the same ratio, the returns for 1884 being 7,820,000 ft. B. M.

Economic Minerals.

Minerals.—As the greater portion of the area surrounding the lake is underlain by Laurentian gneisses and Palæozoic limestones, the districts in which the precious metals might be looked for are very limited, and are confined to the two areas of Huronian indicated on the map. In that shown near Wannipegow River, many claims have been staked, and a small amount of development work has been carried on, but returns as to the assays of ore are not to hand. Gold and silver ores are reported, but apparently they are of small amount.

Molybdenite—Small masses of this mineral are reported by Mr. Tyrrell from granite veins on Little Playgreen Lake.

Iron ore—A deposit in apparently large quantities is found on Black Island, and this will no doubt be again exploited.

Gypsum—Deposits of workable extent are known to exist north of Lake St. Martin, but the needs of the province have not yet called for their being worked.

Building stone.

Building Stone.—The quarries at Selkirk produce a soft mottled limestone of excellent texture, and those at Stonewall and Stony Mountain have been already worked to a large extent. The exposures on Lake Winnipeg, mainly those of the lower and middle beds of the Trenton, are of beds too easily split into thin slabs to be useful for large building operations, so that the building stone is confined to the upper beds which are exposed mainly in the southern part near the settlements.

Lime.—Almost any of the limestones of the district produce a good lime. That from Stonewall is, however, of a fine white colour and is much more in demand for finishing work than that from the lower beds. Kilns were erected at one time at Grindstone Point for the manufacture of lime, but the carriage on the lake was attended by so much difficulty as to discourage the industry. Lime.

Clays.—Pottery clay or clay for fine terra-cotta could no doubt be found at many places along the east shore of Lake Winnipeg, but the only deposit known to be worked is in the vicinity of Lac du Bonnet. The resultant terra-cotta is of a dark-brown colour. Brick-clays in the vicinity of Winnipeg, and in fact in all the southern part of the province, produce a light cream-coloured brick which is much employed. This clay by a much more thorough burning would in some cases become red, but the result would perhaps not warrant the added expense. Clays.

The natural resources of the district may still be said to include the game and fur-bearing animals, though these are fast being depleted as settlement encroaches on the wilderness. The country on the east and to the north still produces many bales o furs for the trader. The natural water-powers of the Winnipeg River, which are within reasonable distance of the city of Winnipeg, should in the near future become of great importance for electrical power and light. All the streams on the east side also have many eligible sites for water-powers and even on the Saskatchewan, the great fall at the Grand Rapid may be some day utilized. Water-power.

Navigation of the Lake.

The great length of the lake, running as it does nearly north-and south, would suggest at once a long navigable stretch leading toward the tide-waters of Hudson Bay, and many years ago surveys were carried out for a railway from the lake to York Factory. At present the principal carrying trade of the lake is connected with the fishing industry, the lumbering and the mercantile supplies of the fur-trading posts situated in its vicinity and along the waters of Nelson and Saskatchewan rivers. Previous to the building of the railway lines to Edmonton and Prince Albert on the Saskatchewan, large shipments were made up this river in flat-bottomed river steamers, as often as the state of the water would admit, and a small tramway was built across the bend from the foot to the head of the Grand Rapids. Navigation of lake.

Navigation of lake.

The shallow nature of the lake renders it a very difficult one to traverse in many parts,—shoals occur in localities far from land—the suspended matter in the water prevents shallow spots from being recognized, and, for small boats, the storms raise in a short time a very heavy sea. As the accompanying map is the first published from instrumental surveys, it may have to be used as a chart by some of the masters of the boats sailing on the lake. It may be mentioned that courses may be taken from the magnetic meridian laid down at the north-west corner, bearing in mind the fact that the variation is decreasing slightly to the south, and at the mouth of Red River is only 14° E. This decrease is hardly appreciable on the ordinary marine compass card. The soundings marked are in feet and are indicated only where actually taken.

Variation of compass.

Notes on the depth of Water and Sailing Courses at various Points.

Notes on depth of lake.

In the southern portion of the lake, below Big Island, the map contains indications of all the shoals noted. The general depth of the water is about 30 feet, but between Big Island and Black Island the channel has been scoured out by the currents to a depth of over 40 feet. A light has been established on the narrow point to the east of Gull Harbour.

Gull Harbour is merely a large bay opening to the north-east. It is a good shelter from the south and north-west.

Grassy Narrows is becoming silted up, so that it is available only for small boats.

Gull Harbour to Grindstone Point.

The water in the channel from Gull Harbour to Grindstone Point, by the west end of Punk Island, is all of good depth at moderate distances from the points. Off Grindstone Point the depth is about 50 feet close to the point and shoals gradually to the eastward. The east shore is flanked by many reefs and the channel to the east of Punk Island is dangerous, unless buoyed.

To Bull Head.

From Grindstone Point to Bull Head there is good water in the direct course. As for shelters in this part of the lake, exclusive of the east shore, the bays on the north and south side of Berry Island can be used, as there is apparently good water near the shore. Shoals may be found between the island and Anderson Point, but another small bay three miles west of Grindstone Point is large enough to shelter boats drawing less than 10 feet of water. Small fishing boats can in medium high water be taken in behind a hook or gravel spit projecting from the east side.

From Bull Head to Dog Head the shores are all steep, and there is good water to near the shore, while there are several sheltered points that would do well for boat landings. Just inside the point at Bull Head there is a wharf for the steamers to wood up at, but this is somewhat exposed to the north. Bull Head.

In the narrows at Dog Head, following a change of wind, a very strong current is started. This often raises a heavy sea for small boats. On Black Bear Island there is a good harbour at the centre of the south side, and is a deep cut nearly through to the north side. The eastern end of this island is a limestone cliff, thirty feet high, on which is established a light. The water off this cliff is said to be very deep, but we found only about 40 feet. In the channel at Dog Head the deepest point was 96 feet near the west shore. This is the deepest we found on the whole lake. The channel to Fisher Bay on the east side of Moose Island is narrow, and at the narrowest part a shoal was struck near the centre of the opening, on which there was only 5 feet of water. Fisher Bay is not much deeper than 14 feet in any part. The Narrows at Dog Head. Fisher Bay.

At the south end of Little Tamarack Island there is a gravel spit behind which fishing boats can shelter. For storms from the east there are several shelters along the east shore, and a good harbour at Rabbit Point, but it was not visited by the writer. Little Tamarack Island.

The western channel from Dog Head to Stony Point, passing Jack Head Island, is much too shallow to be safe for steamers without a pilot knowing of the location of the shoals to the north of Egg Islands.

A gravel bar that is likely to prove dangerous to navigation is situated to the west of Flour Point. It is about five and a half miles from the east shore, and steamers running between Dog Head and Berens Island should not get out of their course to the west or not more than four miles from Flour Point. During low water and in daylight it can be seen as a white bar, but its position, so far out in the lake, renders it very dangerous at night. Dangerous shoal off Flour Point.

The north-eastern point of Commissioner Island is a limestone ridge which shoals out for some distance and should be avoided, as well as the waters between the north end of this and the Twin Islands. Channel north of Commissioner Island.

The course, followed by many pilots through the channel south of the lighthouse is to pass Commissioner Island northward until the Twin Islands open, then run to near the light, say half a mile at nearest, then steer to pass within half a mile of the north-west shore of Twin

Islands and continue on till the islands open again, then avoid the south shore of Berens Island.

Entrance to Swampy Harbour Berens Island.

The entrance to the harbour on the west side of Berens Island is on a line at which the buildings at the dock close on the trees of the north-east side of the harbour. After approaching on this line till the first bushes on the bar close with Little Black Island, follow at the same distance along the bar to the dock. All the water of the east side of the harbour shoals from Berens Island and there are many reefs. As the bar is of gravel and sand built out from the island, deep water would naturally be expected along its face.

The old Swan River Harbour which was used by the inland boats of the Hudson's Bay Company is a small bay on the east side of Berens Island, a corner of which is sheltered by a gravel bar. This is useful only to small boats.

The channel to the east of Berens Island is occasionally used by passing near the north-east end of the island. Two reefs here have to be looked for—Cox's reef and one lying to the east of the present lighthouse.

Course to Sturgeon Bay.

The course to Sturgeon Bay, where some time ago there was extensive fishing, passes between Outer Sturgeon and Bushkega islands mid way, as long bars run from each island. As soon as the islands are passed the course turns sharply for the most easterly of the Sturgeon Islands till well past the reef marked to the west of Buskega Island. This island may be approached quite closely on the west, but there is only a very small opening to the east between the bars. The steamers generally pass to the east of Tree Island, and then south-west, passing well to the north-west of Round Island and thence steering for the mouth of the river. The low point north of the river is shallow, so that it is necessary to swing out a point to the south before making for the mouth.

PHYSICAL FEATURES.

THE WEST SHORE OF LAKE WINNIPEG.

West shore of Lake Winnipeg.

The plateau country through which the Great Saskatchewan River cuts its gorge at the Grand Rapids, as it falls to the level of Lake Winnipeg, is at a height of about one hundred and thirty feet above the mean level of the lake. Its eastern face forms a rather high escarpment extending from south of Long Point, northwards past the limits of the lake. The shore approaches the foot of this slope at the

mouth of the Saskatchewan, and follows it northwards at a gradually increasing distance. Near the Saskatchewan the shores are boulder-strewn, and no rock in place is noticed till north of Selkirk Island, where cliffs of limestone commence and are seen to the mouth of Limestone Bay. Southward from the river the general character of the country is more diversified. A spur of high land runs out to the east, forming the prominent Long Point of the map. The southern face of this is bold, but toward the north the slope is very gradual and on its surface many ridges of boulder-clay are found running northward. These seem to run in a direction parallel to the glacial striæ and are of the nature of drumlins. The contour of the shore-line from the Saskatchewan River to the end of Long Point is evidently influenced very much by these ridges. Very good examples are seen near the Indian Reserve and also eastward. Long bays running to the south are found to have heavy boulder bars on each side at the mouth and ridges forming the sides. Character of shore north of Long Point.

BOULDER-STREWN SHORE NEAR SASKATCHEWAN RIVER, FROM DENUDATION OF BOULDER-CLAY RIDGE.

A section of one of these near the Saskatchewan shows boulders and pebbles in a light-coloured boulder-clay. Many of the pebbles are of limestone, and on the beach in front of this exposure, two miles east of the mouth of the river, are some large boulders of limestone rounded and polished by glacial action. The shore, to Long Point, is quite irregular, and apparently the water shoals away very gradually with many boulder-bars off the points. The south side of Long Point is more regular in outline, having higher country immediately behind the bouldery beach-ridge. On the north side are two large bays cutting in Boulder-strewn shore.

Shores of Long Point.

toward the south, somewhat rounded by having sand-bars cutting off a portion of the southern part. The points between are principally low-lying, with boulder-bars off the central one. The remainder of the shore to the eastern end of Long Point is regular, with gravel and sand beaches. Evidence of the continuation of the Long Point ridge to the eastward is seen in the numerous boulders scattered far off the end of the point. Stratified deposits of sand are seen at the end of the point and extending along its south side for two miles, evidently overlying the till or clay composing the main part of the ridge forming the point. The angle or bay formed at the south-west side of the point is partly inclosed by gravel-ridges running from both sides forming a shallow harbour occasionally used by fishermen.

Wicked Point.

Southward the shore is low, and at the first point is boulder-strewn, the boulders showing in shoals out in the lake. This is called Wicked Point, and possibly deserves its name. Near it is the first exposure of limestone south of the Saskatchewan River. The section is given here, as it seems to belong to a higher horizon than the other limestone exposures of the lake. The top of the rock is 14 ft. 5 in. above water, and the beds are in the following descending order :—

	Feet.	Inches.
Hard dolomitic limestone with a few shells and corals, the whole more or less lumpy......	5	4
Porous fucoidal dolomitic limestone....................	2	3
Thin white beds very much shattered and somewhat rotten, cavities filled with white clay-like material.	3	4
Yellow porous dolomitic limestone, fucoidal....	2	3
Covered by shingle to water's edge.....................	1	3
	14	5

Exposure of Silurian.

From one to two feet below the water are seen beds of a blue shaly limestone.

This exposure extends along the shore for about 300 yards, the apparently horizontal. Above is a thin deposit of two or three feet of boulder-clay, and at the southern end of the cliff there is a mass of this material piled up behind the rock. The clay contains a great number of limestone boulders, evidently from this ledge, with a few of granite or gneiss. The fossils obtained from this place, principally from the upper beds, seem to indicate Silurian age, of about the same horizon as the lowest rock at the Grand Rapids.

Low shores.

From this first exposure south to the next, there is very little variety in the shore-line. The country bordering the lake is low and flat, the rocks being covered by a thin coating of boulder-clay. Boulders are strewn on the points and gravel- and sand-bars extend between, forming the present shore-line. Behind this as a rule is a wet mossy muskeg reaching back to the higher, more thickly wooded

ground. About six and a half miles north of Dancing Point the shore is strewn with limestone fragments, and a mile south the underlying beds become exposed, showing eight feet of limestone in a series of receding steps. The beds, of a hard mottled dolomitic limestone, are thin or split into fragments. The exposed surfaces are rough and covered by fucoid-like markings. They resemble the Selkirk Island beds, and are apparently not far below those of the last exposure. South from Long Point.

These same beds are seen again about a mile farther south, and the shore is there generally covered more thickly with scattered limestone pebbles and gravel.

At Dancing Point, a low cliff shows 4 ft. 6 in. above the water, and extends 100 yards along the shore. The beds are nearly horizontal and the surface forms a flat table which has been somewhat smoothed by glacial action and shows a few striæ. These are running nearly S. 35° E., with some, seemingly older, running S. 63° E. This rock is a dark semi-crystalline dolomitic limestone, similar to that on Selkirk Island (north end), and contains a few badly preserved fossils of the same horizon as those found on the western shore opposite the north end of Selkirk Island. Dancing Point.

From Dancing Point southward, the shore for a short distance is very shoal and is strewn with boulders. The whole bay seems to be rather shallow. The first point south is boulder-strewn and but very little above the lake. Four miles from Dancing Point the beach gradually becomes freer from boulders, and is then almost entirely a sand-bar with low country behind. In the centre of this long bay a small stream, the War-path River, cuts through the sand-bar. In the spring no doubt the river is of some size, but at the time of our visit (August) the water flowing across the bar was only deep enough to float a canoe. Near the War-path River.

The next rock noted on the shore was a small exposure of yellow dolomitic limestone at Shiel Point. This is in a low cliff showing about 6 feet of apparently horizontal beds of fine-grained mottled dolomite. They are marked with fucoid-like markings, and vertical sections show numerous small cavities such as might be left from the dissolving away of salt crystals. The beds weather a dark yellow, almost an orange. In general appearance the specimens from this place have a resemblance to the rock at Stony Mountain. The top beds, three or four feet thick, are quite hard and fine-grained, while the lower ones are not quite so hard and seem to contain more earthy impurities. The beds exposed seem to be barren of fossil remains. Shiel Point. Rocks resembling Stony Mountain limestone.

Morass Point. The shore south around the rest of this bay has a fine high gravel- and sand-beach, but toward the southern point the country behind is low, in fact, a small lake lies back of the point and drains east to the lake farther to the south. The high bar ends at the above point, leaving the shore further south rough and shallow.

Carscallen Point. At Carscallen Point, several exposures of limestone are seen in horizontal beds rather dark in colour. Other exposures similar in nature occur along this shore as far as Clark Point, and details are to be found in the topographical descriptions of the Upper Mottled limestone.

Clark Point to Grand Island. South to Gravel Island, about four miles, the shores are high and well timbered, with a beach principally of limestone gravel. South of this island the shores are boulder-strewn.

Sturgeon Bay. Sturgeon Bay has a width of eleven miles, and from Tree Island to the mouth of the Mantagao River the distance is sixteen miles. In the mouth of the bay are seen the Sturgeon Islands, narrow boulder-strewn ridges, with groves of poplar and spruce. The remainder of the bay is open, but is generally not deep, the average being about three fathoms. The shores to the east are flat and low with boulder-bars in front, while to the south they are somewhat higher and steeper, having gravel beach-ridges. The bay at the mouth of the Mantagao River is nearly closed in by a gravel bar which is being built up from the west side, and the inclosed part is rapidly filling up, and is now mostly covered by rushes, making it a famous resort for ducks in the autumn. A low muskeg-flat extends from the east side of Sturgeon Bay to the bottom of Lynx Bay, so that from a distance the lake seems to extend through, thus apparently cutting off a portion of the land which terminates in Saskatchewan Point. On some of the older maps this part is called Lynx Island. In Lynx Bay it is found that this low strip is separated from the lake to the north by a high sand- and gravel-bar which now effectually seals the passage, otherwise in high water a canoe-route might easily be found through the marshy strip. Many examples of these high bars built entirely by wave action are found, and another may be here cited. The point known as McBeth Point, which is just to the east of Cat Head, is connected to the high land to the south-west entirely by a wave-built bar with perhaps larger proportions than any other on the lake, the material being ready to hand at the cliffs running from Lynx Bay to Cat Head. In Lynx Bay the limestone débris is found scattered all along the east side.

Mantagao River.

Lynx Bay.

High gravel-bar.

Kinwow Bay. Kinwow Bay is a long narrow inlet, with an average width of two miles opening out to the lake in greater width. The distance

across the mouth from McBeth Point to Willow Point on the east is over eight miles. At the upper end of the bay the country is fairly well wooded, and spruce of economic value as timber is reported on several small streams. Behind the beach on the eastern point of the bay is a series of sand-dunes, averaging from ten to fifteen feet in height. The timber seemed to be small. At Stony Point the sand and gravel is piled into a high heavy bar, projecting into the lake toward the east. The eastern end is protected by a small accumulation of boulders at the water-line. A line of boulder-bars runs from the extreme end of Stony Point to the shore, four miles to the south, probably the remains of a series of boulder-clay ridges similar to those forming islands to the north.

Stony Point.

Following the shore southward to the mouth of the Jackfish River, it is seen to be rather high and straight, with occasional small exposures of clay above the beach. These are found to be cuttings into the side of a ridge of boulder-clay, slightly modified, showing very faint traces of stratification. At the Indian Reserve at Jack Head, the timber has been cleared away and the ridge is clearly seen. It is about fifty paces wide on the crest, sloping to the swamp behind. The shore just here, by a series of curves to the south-east, leaves this ridge and gains two or three similar, though smaller ones, lying at short intervals to the south-east. The Jackfish River cuts through the first ridge, leaving its bed full of large boulders, flows through a low flat hay-meadow and issues to the lake through a gravel-bar over a boulder-strewn shore. Behind the gravel-bar the stream is deep to near the boulder-clay ridge, where the channel is filled by boulders. The shores southward are either low and muddy or boulder-strewn, according to the nature of the land behind. Where a boulder-clay ridge is reached, the points and shores are boulder-strewn, but otherwise the timber grows to near the water-line. The shores of Fisher Bay are all low, and the south corner is marshy.

Shore near Jack Fish Point.

Bouldery ridge cut by Jackfish River.

Fisher Bay.

The timber of the west shore has already been largely cut off, and two saw-mills, one on the west shore and one on the Fisher River, have ceased operations. On the east side, the shores are low and the country behind is also not elevated much above the lake. The points visited are merely reproductions of the same kind as that described on Moose Island, low boulder-ridges separated by swampy strips.

The shore to the south is fully described in dealing with the rocks exposed, but in brief, from Dog Head south to Little Grindstone Point, cliffs of limestone front on the lake. The south-western shores of Washow Bay are, however, low, and on the west shore of the southern

Character of shore to Big Island.

Big Island to Red River.

part of the lake, from Big Island to the Red River, no prominent high points are found. The country, however, slopes up from the lake and many settlers' houses are seen in the cleared places. Steep shores are found near Gimli, but are seen to be cut-banks of stratified clay, a deposit formed when the lake was at a higher level.

RIVERS ENTERING THE LAKE FROM THE WEST.

The two large streams, the Saskatchewan and the Dauphin or Little Saskatchewan rivers have been previously described in various reports. The geology and general description of the Saskatchewan in the vicinity of Lake Winnipeg is given in J. B. Tyrrell's report on North Western Manitoba.*

A general description of the Dauphin River is also given by the same writer in the Summary Report for 1889.†

War-path River.

A traverse was made down the southern branch of the War-path River, by crossing from the Little Saskatchewan River, at the bend, by a two-mile portage to the westward. The trail crosses a low country, imperfectly drained, half the distance being through wet mossy muskeg. Belts of timber of small growth, principally poplar and spruce, were passed through. The stream, at the point reached by the trail, is flowing in a small channel cut down only about five feet and fifteen feet wide. In the summer hardly enough water is running to float an empty canoe. Owing to the gradual descent, small accumulations of boulders serve to dam the water back in long quiet stretches. The general direction of this branch is north-northwest in a nearly direct line, almost a prolongation of the direction of the upper course of the Little Saskatchewan River. The country passed through is a gently sloping plane inclined to the north, wooded with poplar and a few fair sized spruce. No exposures of boulder-clay or any underlying rock were seen on this branch, and whether the till is modified or not is conjectural. The western branch joins that from the south nearly five miles west from the lake, and from there the course of the stream is changed to the east. The banks are only about eight feet in height in the lower part and continue to near the lake. The underlying rock is met with only near the lake, and consists of a hard, lumpy, yellow dolomite, succeeded by a close-grained, hard, yellow bed with numerous holes through it like worm-burrows. These resemble rocks belonging to the Stony Mountain section but the absence of fossils leaves the horizon very uncertain.

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*Annual Report Geol. Surv. Can. vol. V (N.S.) 1890-91, p. 144 E *et seq.*
†Annual Report Geol. Surv. Can. vol. IV (N.S.) 1888-89, p. 19 A- *et seq.*

Fisher River enters Fisher Bay from the west, at its extreme southern end. It rises to the south-west in several branches. The two principal ones meet at the Forks at a distance of about twenty miles from the mouth. The river is navigable for canoes to the Forks, and in that distance the fall is slight, being confined to three localities, a rapid at the Mission and two dams constructed by lumbermen farther up. The saw-mill near the mouth of the river was supplied by timber from some groves of spruce above the Forks, but these seem to have been exhausted. Of the country in the vicinity of the Forks the following notes were taken.—The banks are not very high, but the valley seems to be about 150 yards wide and fifteen feet deep. The surface of the country appears quite level with good soil. The timber, mostly poplar, has been burnt, and a large portion of this valley would in a few years become prairie. It was also learned that, to the west, the general character was that of a dry rolling country, covered by poplar with open meadows, but to the south-east much low swampy land occurs. From the stream very little spruce is seen. As to the nature of the underlying formations little could be learned. At the dam, four miles down from the Forks, a section of the bank showed one foot of black loam with stratified clay and a few pebbles. Boulders are found in the bed of the stream mainly at the rapids. Stratified sandy clay is also shown lower down, but this seems to be river deposit. Fisher River.

The land bordering the stream at the lower part is reserved for the Indians. Their reserve is evidently a valuable one, having good facilities for agriculture and dairying. The Indians are living in well-built houses, with fine gardens, and many have good herds of cattle. On some of the farms were small fields of wheat, oats and barley, growing well. Fish, when not abundant in the river, are caught in the lake, but whitefish are seldom obtained nearer than Tamarack Island. The river is navigable for small boats of less than four feet draught up to the Mission and Hudson's Bay Company's establishment, while larger craft might, if the bar at the mouth of the river is cleared, reach the mill, about a mile up. Indian Reserve at Fisher River

ISLANDS OF LAKE WINNIPEG.

Big Island is seventeen miles in length, and of an average width of three miles and a half. The western shore is low with hay-flats and marshes, but the eastern and southern portion is more elevated and better adapted to farming and stock raising. Nearly all the surveyed sections on this part are occupied by settlers of the Icelandic colony. Big Island

Big Island. The higher parts are well wooded with poplar and some small spruce birch, &c., and the land has to be cleared for use. The northern part of the eastern shore is underlain by limestone, and often the soil is light and fit only for grazing purposes. The remainder is covered by a re-assorted glacial deposit, clay with some sand, and boulders are seen on the shores, especially to the south. Shoals occur south-west of the island extending out at least two miles from shore.

Black Island. Black Island, though not as large in area as Big Island, is much more prominent, as its surface inland rises much higher. Its length is twelve miles and a half, and breadth four and a half. It is well wooded, and a mill for some years was located at the south-west corner, engaged in sawing timber cut from various points near its shores. An iron-ore deposit on the south side has been known for many years, and on Jeffrey's map of 1762, showing Canada and northern part of Louisiana, Iron Island is shown a short distance south of the Narrows, evidently the same as the Black Island of to-day. A description of this deposit is given by Mr. Tyrrell, in the Summary Report for 1889, pp. 12-13.

Punk Island. Punk Island, to the north, is smaller, and is composed generally of the lower sandstone capped by thin beds of limestone. A small amount of timber, mostly black spruce, is found on the high parts, but birch and poplar are the prevailing trees.

Berry Island. Berry Island, in Washow Bay, lies well out to near the line between Grindstone Point and Bull Head, at a distance of six miles from the former. It consists of two masses of boulder-clay, the larger one to the south containing large angular blocks of limestone partly striated, and large boulders of Laurentian gneiss. The mass is in all probability lying on a part of the Winnipeg sandstones not eroded to the usual depth, having been protected previous to the passage of the glacier by a capping of limestone which if still exposed would be found above water-level, judging by the outcrops of the vicinity. There is evidence of a former point having connected this to the peninsula to the south-west, the remains being in the form of a line of shoal water and boulder-bars. The two masses forming this island are now connected by boulder- and gravel-bars forming a narrow neck in the centre.

Black Bear Island. Black Bear Island is a continuation of the limestone cliff of Dog Head. The island has been nearly cut in two by a deep bay running in from the south, which forms an excellent harbour for all classes of boats. On the outer side, the limestone exposed on the beach has been glaciated, and shows grooves running S. 48° W. Coming up from the

open part of the lake, and at right angles to the shore-line, are also seen several scratches resembling glacier markings, but irregular and sometimes slightly curved, and no doubt, due to the effect of the present lake ice shoving the boulders upward from the edge. Striæ seen on the south-east side also run S. 48° W. There has not been much glacial débris left on the surface of the higher parts, and it is only seen in the boulders along the shores. Toward the western end the gneissic boulders increase in number, and for a considerable distance south-west form bars and small islands. Just west of this island, another smaller one seems to be made up entirely of boulder-clay—the boulders from which, form bars that run with few interruptions to near Narrow Island.

Snake Island is, like Black Bear Island, composed of limestone of the same character as Dog at Head. The eastern side is high, but it slopes down to a low shore on the west. Snake Island.

Narrow Island shows only bouldery shores and is probably an oblong hill of boulder-clay resting on the limestone which is here not far below the surface. Narrow Island.

The depth of the water surrounding these islands is not great, except to the east and south of Black Bear Island. In the pass south of Snake Island the depth at the narrowest part is fifteen feet, but shallows to the west, and in the bay into which Moose Creek empties, the channel up to the mouth of the creek is not more than five feet deep with a shoal in the centre of the bay.

Of the timber on these islands little need be said. A good deal has already been cut for use on the steamboats, and although comprising poplar, spruce and birch, it is all of medium size.

The Moose Islands, lying in the entrance to Fisher Bay, so nearly fill it that three comparatively narrow channels only are left. The larger one lies near the eastern shore, and is long and narrow, being thirteen miles long and averaging a mile and a half broad. Its shores are altogether of drift material and no evidence of older rock is seen. From the character of the bars at the extreme ends and of boulder-ridges along its eastern and western shores, the drift appears to be arranged in a series of interrupted parallel ridges of varying height, such as are called drumlins. The few islands in the channel to the east also show the same formation. Several of these are now connected by low land with the mainland to the east. The western side is straighter and with the exception of a few small bouldery points is much steeper. Moose Island

Towards the north end a few ridges run northward, continued as bars out in the lake, and thus form narrow bays open to the north.

The northern point is very rough and large Laurentian boulders extend in a bar for at least half a mile beyond the point, toward the eastern bluff on Tamarack Island.

Little Moose Island.

The western Moose Island is smaller and is generally called Little Moose Island. It is four miles and a half long and nearly two in width. At the north end, two ridges form the eastern and western points of a large open bay. The eastern ridge terminates in a long gravel- and boulder-bar, but farther south is scattered and several small ridges come out on the southern side of the island. The western ridge is continued across the island and forms shoals out in the lake to the south.

Scotch Islands Group.

The Scotch Islands to the west of Rabbit Point is a group of islands which have been called the Scotch Islands. Locally, however, these are given individual names. The largest is Tamarack Island, a low wooded strip. Just to the north a small but higher one, well wooded, is called Little Tamarack, as it lies close to the end of the larger one. The others of the group are Egg Islands and Jack Head Island.

Tamarack Island.

Tamarack Island is a long low strip of muskeg, seven miles and a half in extent and a mile wide, on which is a small growth of tamarack. This is relieved by three or four 'bluffs' of larger timber, occupying higher ridges or mounds toward the centre. The eastern part consists of a long low point stretching toward Little Tamarack Island. The eastern face of this has a high sandy beach-ridge behind which is a mossy muskeg bearing only stunted spruce and tamarack. The lake in front is shallow and full of bouldery shoals. The north shore is low, broken by a ridge of higher land running out to form a rough boulder-point. This ridge can be traced south-west across the island and forms a similar point to the south. Shoals running on this line extend northward to abreast of Little Tamarack Island, showing a nearly continuous ridge of bouldery material, probably of glacial origin running in the direction of the glacial movement. The waves of the lake are fast eroding the soft material of the western and northern shores where unprotected by the boulder-deposit, so that at several places stumps of trees are found standing out of the water, while the shore behind is apparently nothing but soft peaty matter. A few bars of gravel and boulders can be seen to the west and south, one opposite Little Jack Fish Point has a small grove of poplar on it and might therefore be called an island, possibly Louis Island of Hind's map.

Little Tamarack Island is a limestone ledge, low on the western side, but on the north rising ten or twelve feet above the water, showing

there ledges of thin-bedded limestone. The eastern face is built up principally from the broken material of the cliff, and has formed a high ridge behind which are several ponds and meadows. The northern half of the island is high and well wooded with spruce and poplar, but the southern part is mostly willow scrub with a few open meadows. Little Tamarack Island.

The Egg Islands are a connected chain of low bars which in high-water would be resolved into four. A few bushes on the smaller ones and one grove of larger trees, (the Bluff), on the largest, are all the foliage to be seen. These bars are evidently all of glacial origin, and seem to be a continuation of, or are similar to, the series to the south crossing Tamarack Island, and run generally in the direction of the glacial striæ. The shores are generally very shallow, and the west side is much shallower than the east, many boulders being scattered some distance out,—about five miles. North of these islands is a high bar of limestone pebbles. This has no doubt been pushed up by ice from a submerged limestone ledge. As there are no bushes or other high objects on it, and from its position in the middle of the lake, it is dangerous to navigation and should be marked carefully. Egg Islands.

The remaining island of this group is Jack Head Island, lying directly east of a point bearing this name. It is rather small, but quite prominent, being well timbered and high. In shape it is an oblong, a little longer than its breadth, which is half a mile. From its eastern point, which is piled high with limestone gravel, numerous small rock exposures are seen all along its northern and western shores, rising to about fifteen feet. The southern shores are generally low and boulder-strewn. The glacial striæ were observed to run S. 25° W., or nearly parallel to the ridge composing the Egg Islands. Jack Head Island.

Commissioner Island Group.—A line drawn from Inmost Island to the eastern side of Berens Island, would run along a chain of islands that seem to be composed altogether of drift material, probably of the nature of drumlins, judging from the general direction of the chain and that of individual islands which is nearly parallel to the glacial movement. The southernmost one is a lenticular mass of boulder-clay covered with poplar and birch. From the south end runs a long gravel- and sand-bar nearly half a mile, then suddenly turning east it reaches nearly to Commissioner Island. The latter part is evidently recently built up by wave action with material derived from the larger bar. At the north end of the wooded portion, a small exposure above the beach, shows light-coloured boulder-clay. The second island in the group is larger or the wooded portion is of greater extent. Shoals seem to connect the two, and both occupy a position near the western Commissione Island Group.

Twin Islands. edge of a shallow area reaching to Commissioner Island. The Twin Islands appear to be the visible parts of two ridges lying in deeper water. The shores are boulder-strewn and similar to Plunkett Island which lies half-way to Berens Island to the north. These, as noted before, have deeper water surrounding them, the steamboat channel passing to the south of Plunkett Island.

Sand Hill and Nut Islands. Another ridge or line of ridges crosses Commissioner Island from its north end to the southern point, following the west shore, and is continued south on Sand Hill Island and Nut Island. Sand Hill Island consists of two ridges, one slightly in advance of the other, while on Nut Island one ridge only is seen. The shores of both are strewn with boulders and bars extend toward the south end of Commissioner Island.

Commissioner Island. Commissioner Island is generally low, consisting of one series of ridges as mentioned above, to the east of which stretches a low tamarack swamp, somewhat like that of Tamarack Island, west of Dog Head. Cranberry Island is, however, the older term, and is descriptive of the general character of the island. At the north-east corner is found a large rectangular bay opening to the north. This was used as a harbour by the first steamer on the lake, the *Commissioner*. The shores are generally low and in sheltered parts the muskeg reaches to the beach. The point which forms the eastern side of the harbour is found to be a low shelving limestone ridge, covered mainly by boulders, and is continued far out under water, so that steamers from the south turn for the lighthouse channel only after opening the Twin Islands. Off the north shore, farther west, are extensive shoals with boulders showing occasionally, but they do not seem to extend as far north as the Twin Islands.

Berens Island. Berens Island is a long low wooded island lying to the west of Pigeon Point and the mouth of Berens River. Its longest diameter is a little over eight miles and lies in direction about north-east and south-west. The northern half averages about two miles wide, but south of this it is increased to nearly four miles by a projection on the east side. The east and west shores are not elevated much above the beach, but a ridge of higher land is said to run the length of the island from its extreme points. The shores are generally boulder-strewn and shoals run to the south-west and are also seen off the north point. Limestone ledges are found on the east side, generally low, shelving out under water with high ridges of shingle in their vicinity. Along the north side, smooth glaciated surfaces of limestones are found at the water's edge, and to the west, the beach,

after leaving the limestone exposures, becomes nearly pure sand, and is continued as a sand-bar nearly the whole distance to Little Black Island.

Little Black Island.

Little Black Island is formed from an exposure of horizontal beds of limestone, the débris from which has produced a beach and two bars, running to the east and nearly connected with the sand-bar from Berens Island. On the outer shore is a cliff of over twelve feet of fractured limestone beds, the shingle from the denudation of which spreads nearly around the island. On the higher land of the central part is a thick grove of black spruce, and though the island is of small extent—half a mile in diameter,—it is conspicuous. In the bay between this and Berens Island, formed by the projecting bars, a small harbour has been used for some years by the fishing companies.

Inmost Island

To the south-east of the entrance to Kinwow Bay a small island lies within one mile of shore. It is oval in shape, pointing to the north, and is about half a mile in length and twenty chains in width. It is well wooded with poplar, birch and spruce, and seems to be high in the centre. This is probably a mass of boulder-clay lying on the surface of the flat-lying limestone which is exposed on the northern beach. This island is marked on Hind's map, (1858) as Birch Island, but since then, various collections of fossils brought from there have been labelled 'Inmost Island.'

On the northern end the beach is strewn with flat slabs of a fine grained dolomitic limestone, containing many rounded concretions of dark cherty matter, averaging about four inches in diameter. The eastern and northern shores are piled high with pebbles of this rock, but the western side is mostly covered with gneissic boulders on the shore and scattered on its slope out into the lake. From the southern point a bar of limestone gravel extends southward to very near the mainland. Near the island this bar is high, but it gradually lowers, the greater part of its length being just below the water-level. Northward from the island a few bars are visible, being probably ledges of the underlying rock scattered over with boulders. Half way to McBeth Point another shoal shows a line of boulders just above the water. In the bay east of the island there is a depth of twenty-four feet with rock bottom and also about the same immediately to the west.

Lying off the eastern entrance to Sturgeon Bay, and northward from Saskatchewan Point, are three quite prominent islands. The most northerly one of the group is known as Outer Sturgeon Island

Outer Sturgeon Island.

and is the only one on which the underlying rock is exposed—although the presence of gravel-bars on some of the others would suggest the probability of the limestone being not far below water-level. The Outer Sturgeon Island has a diameter of about one mile and in shape is nearly square with the diagonals pointing to the cardinal points. The broken material from the cliff at the north point has been carried for some distance around the island, seemingly in both directions, toward the south end where there is a mass of this gravel forming a bar. The south-western end is all low, but along the shore is a gravel-ridge behind which are several marshy ponds. This beach-ridge is high, averaging eight and ten feet above lake-level. Part of the material has been pushed up from the lake, as the bar is no doubt built on the shelving limestone, but a large percentage has been transferred from the northern end. At the extreme south point, the gravel is being carried from both sides out into the lake forming a bar which at present extends half a mile from the island.

Inner Sturgeon Island.

Nearer Saskatchewan Point are two islands. These are probably the Bushkega Islands, of Hind's map. The western one is commonly called Inner Sturgeon Island, and is the largest of the group, being over two miles in length but not very wide. It is formed by the junction of two long narrow islands, the one lying in advance of the other, the northern one slightly to the east. Between these a high gravel- and sand-bar has been built, forming a bay open to the north-west, but affording good shelter from the east and south. The water in this bay is deep, soundings in the centre giving eighteen feet outside, thirteen just inside the points, and eight feet close to the bar. The shore of the east side of the bay, as well as the point at the west, is rough with large boulders. These two masses which form the island are both strewn with boulders. The shores are rough, and to the north and south extend long shallow bars on which at intervals are seen large boulders showing above the water. The shoal running northward commences at the extreme north-eastern point, and runs north, and for about a mile boulders can be seen. The steamboat channel is a little north of the middle of the opening between this and outer Sturgeon Island. To the south, the lake is quite shallow with numerous bars running off from this island.

Bushkega Island.

From off the eastern part of the island a long bar extends south to near the other Bushkega Island, which is smaller than the first and is formed in a similar manner, a couple of masses of till forming two islands have become joined by a wave-built bar. The eastern half is

well wooded, and besides a lot of Laurentian boulders on its shores it has a considerable extent of gravel- and sand-beach, especially at the southern end where the gravel is piled into a high bar. The channel south, between this and the mainland, is at present very shallow, although in early times this is said to have been the usual boat-route and formerly used by some of the steamers. The bar from the island is now built nearly across the bay but shows only at intervals above the water.

In the middle of the mouth of Sturgeon Bay there is a group of small islands eleven in number, called Sturgeon Islands. They are all either long ridges or lenticular masses forming narrow islands, and are all lying in a general north-and-south direction. As to structure, some of them are quite low with a heavy beach-ridge generally of boulders on the more exposed side; others, such as Tree Island have a higher ridge probably of boulder-clay running down their length, flanked by beach-ridges. These boulder-clay ridges are sometimes interrupted and some of the islands at the eastern side of the group are evidently formed of several pieces of a ridge joined by the beach-ridge. Their shore-lines show nothing but transported material,—boulders of gneiss and a fine-grained limestone like that at Cat Head,—but of solid rock nothing is seen. As all these ridges lie approximately in the direction of the glaciation, they may be described as drumlins. Sturgeon Islands.

The large island lying north of the St. Martin Islands is locally known as Reindeer Island. It is nineteen miles in length, with a greatest breadth of six and a half, but an average of four miles. The surface is all low, consisting of patches of timbered land surrounded by hay-flats or marsh, so that it has, from a distance, the appearance of a cluster of islands similar to those farther south. Its shores are not bold and along the south-east side are protected by shoals. From the south point along the eastern side there is a short distance in which the shore seems slightly higher, and in one place rises to seven feet, showing light-gray boulder-clay with limestone fragments and pebbles of Archæan gneiss. A little south of the middle of the eastern side an island lying just off the shore has been connected with the main shore by a sand- and gravel-bar running from the north. Behind this the bay forms a land-locked harbour which, in low water, can hardly be used as such, since the entrance is too shallow. In the summer of 1890, the depth of water in the bay was about four feet and in the channel leading to it about two feet, with a rough bouldery bottom. A few years previously this was used as a harbour by the fishing craft, an entrance being then found through the sand-bar, but this has since closed up. Reindeer Island.

Near the north point, boulder-clay was again seen, containing small pebbles, but the shore was strewn with slabs and boulders of a mottled limestone containing *Maclurea Manitobensis.* This seems to be the same rock as that at Little Black Island, but it is not seen here in place. The larger boulders are glaciated, and as many of them are broken, the striæ appear on one side only.

Western shores of Reindeer Island.

The north-western shore has one large indentation running to the south-east and on the west side of this a small harbour has been used by the fishing companies. In front of this bay are several islands—four of them timbered, the rest merely shoals. They all seem to be formed of drift material, but some derive their shingle probably from shelving limestone beds beneath the water, as several have strong beach-ridges of limestone pebbles. The possibility of there being limestone beds here, but slightly submerged, is confirmed by the fishermen, who report at the western point near the harbour, a flat table of rock which appears at very low water. The south-western side is low and the shores near the south end are without beaches, being protected by many islands and shoals. The timbered bluffs come out to the shore and form points with low land lying between, often in the form of hay-flats that seem to run nearly across the island. An elevation of ten feet in the level of the lake would resolve the southern end into a cluster of islands corresponding to that lying just to the south —the St. Martin Islands.

St. Martin Islands.

These seem to be a series of small narrow islands, many of them in line connected by shoals, showing them to be merely higher points of an interrupted ridge. Others are oblong masses of till, and where exposed show an unstratified mixture of light-coloured clay containing large Archæan boulders. The islands generally have their longer diameters running north-and-south, and are flanked on both sides by bouldery beach-ridges. Exposures of limestone may be found on some during very low water, as several of the larger ones just to the south of Reindeer Island have, added to them, large bars of limestone pebbles which are probably derived from below the water-line.

George Island.

George Island, being formed by a high plateau connected to a strip of lower land, first appears as a high island only two miles long, but from a nearer view two isolated bluffs to the south-east appear as separate islands. These are, however, included in a high sand-bar stretching from the larger part to the eastward, the outer bluff being at the extremity of the bar. The main body of the island is about two miles long, in a north-west and south-east direction, and a mile wide. On the southern shore the highest point is estimated at seventy

feet. As far as could be seen the hill or plateau forming the island is composed principally of sand and clay, with the upper part only exposed. Where a small exposure was seen it consisted of a liberal

BOULDER BEACH, GEORGE ISLAND.

assortment of boulders at or on the surface of a bed of water-worn gravel and pebbles rudely stratified, with sandy beds below. The face of the bank was everywhere hidden and covered with vegetation, so that a complete section could not be made. The beach in front of

Bouldery shores. this escarpment is a heavy boulder-ridge, the boulders seeming to run out into deep water. Towards the west the top of this escarpment is not as high, averaging about forty feet, with the same character. In a bay on the western side, the boulder-beach is replaced by sand, and the banks behind are also of sand piled in high dunes, one or two reaching fifty feet. The northern end of the island is of gravel and boulders, though the banks are not very high. On a point on the eastern side, cleared of timber by fire, the edge of the terrace can be seen from the shore, at an elevation of about twenty feet above the water. It is entirely grass-grown and boulders are liberally scattered on its surface and on the slope.

Formation of eastern part. The two outlying wooded patches seem to have been separate masses of boulder-clay, as their north and south ends terminate in bouldery points. The higher part of the island is evidently a terrace sloping to the north, and where worn into by the lake, as it is on nearly all sides, it leaves piled up in front of it a high ridge of boulders.

Little George Island. Little George Island, west of George Island, is small and triangular in shape, with the apex pointing south. On the south-west side, the lake is cutting into the western side of a ridge which runs from the south end of the island towards the north. The eastern shore is low, but has a strong shore-ridge of boulders. The northern side or base of the triangle is a sandy bay with sand- and gravel-beaches. From the two points shoals run north and north-easterly, which protect the bay from all but northerly winds. The northern point and all the west side is thickly strewn with boulders and there appears to be a line of shoaler water farther north, as there are several boulder-bars lying a couple of miles from the island. Evidently the ridge, which is highest at the south end of the island, has been greatly denuded. South of the point of the island the water is deep, and the shores to the south and west are steep.

Ridge of gravel and sand. The ridge is about 300 yards long and rises some thirteen to fifteen feet above the bouldery shore, or twenty-one feet above present water-level. The surface is strewn with water-worn or glaciated boulders, partly embedded in the soil; beneath this, as far as could be learned, the whole mass of the ridge is of gravel with a little sand. The pebbles are all of Laurentian material and well rounded.

SandyIslands. The group of islands farther out in the lake and north of Little George Island are known locally as Sandy Islands. These are three in number, lying approximately on a line pointing towards Long

Point and the George Islands. The middle one is the largest and highest of the group and is somewhat irregular in shape. The southern part is high and at the south point there is a hill about fifty feet high. Boulders are strewn on the surface and falling down the slope of gravel, sand and clay which forms the hill, help to swell the pile of boulders which here form the beach. Running east from this boulder point is a long gravel shore, behind which is seen a terrace of stratified sand and gravel. The surface of this slopes regularly from the high hill seen at the west, towards the eastern point of the island. At the middle of the bay, the escarpment is a short distance back from the shore and the top of the bank is about fifteen feet above water, but rises rapidly toward the west. This bay and a small one on the west side are free from boulders on the shore, but all the rest of the shore is thickly covered, more especially the south-western part. The northern and eastern points are low with bouldery shore-ridges. The other two islands of this group are both long narrow ridges of gravel and sand covered by a lot of boulders, making rough shores. Between the western island and the middle one are several shoals. South of the eastern island, and out to a distance of a mile and a half, are several shoals lying in the direction of Little George Island. These seem all to be of gravel and boulders and are lying in a general north-west and south-east direction. To the west of the group the water appears to be deep, that is, the average depth is about ten fathoms, which is also found between the islands and Long Point. Of the trees on these islands it may be said that besides a scattering of spruce and birch the main timber is poplar. On the higher part of George Island and the middle of Sandy Island there is some spruce of a medium size. Sandy Islands.

Selkirk Island lies ten miles north from the mouth of the Saskatchewan River. Its length is five miles, with an average breadth of a mile. The shores are generally boulder-strewn, but intervals are seen occupied by limestone beds in place. These exposures are noted under the general descriptions of the Upper Mottled limestones, and occur at the north end, on the west side and near the south-east corner. Gravel-beaches are always found associated with the rock exposures. Those at the north end, furnish a large mass of material which on the west side of the island is formed into a long hook, behind which is an excellent harbour. The whole island is wooded generally with spruce and poplar. Near the harbour at the north-west point, a clearing has been made for a fishing station and the timber cut appears to be small, consisting of spruce and tamarack. Selkirk Island.

Horse-shoe Island.

Horse-shoe Island, called, locally, Pony Island, is a small wooded limestone knob just off the south-east corner of Selkirk Island. The limestone débris from the eastern face of the low cliffs has been carried westward by wave-action around both north and south points, and this is continued towards the large island in the form of two long bars, thus inclosing a small bay which is extensively used as a shelter for fishing boats, and may probably be found large enough for a fishing station. The shape of the island is thus, roughly, a horse-shoe with the opening toward Selkirk Island and the wooded part occupying the toe portion of the shoe.

SYSTEMATIC GEOLOGY.

CAMBRO-SILURIAN.

Correlation of formations.

Cambro-Silurian in Winnipeg basin.

The Cambro-Silurian is found resting on the uneven surface of the Archæan and conformably below the Silurian which outcrops at the Saskatchewan River, Lake St. Martin and in several other places south to Stonewall—while the Archæan forms the eastern shore of Lake Winnipeg, leaving thus a long strip in which the Cambro-Silurian is seen. The lower member is a sandstone followed by shales and limestones bearing fossils of Trenton age. Above this, red shales and reddish and white limestones form the beds referred to the Hudson River or Cincinnati formation.

Formations in Minnesota.

In Minnesota, the sections carefully worked out show that below the Hudson River formation—divided there into two divisions—are found beds of the Trenton, Black River and Chazy formations, while in Manitoba no rocks are found below the Black River and of that the upper part only.

The following table of formations for Minnesota and Manitoba shows the positions relatively assigned to the Manitoba formations :—*

*The subdivisions in Minnesota are those adopted in the introduction to part II of vol. III Geology of Minnesota.

Table correlating formation of Manitoba and Minnesota.

FORMATIONS IN MINNESOTA			FORMATIONS IN MANITOBA.		
Hudson River or Cincinnati Period.	Richmond group. Utica group.		Trenton Period.	Stony Mountain Utica ?	Limestones and shales.
Trenton Period.	Trenton group.	Maclurea beds.		Trenton.	Upper Mottled limestone.
		Fusispira and Nematopora beds.			Cat Head limestone.
		Clitambonites beds.			Lower Mottled limestone.
	Black River group.	Fucoid and Phylloporina beds.		Black River ?	Winnipeg sandstone and shales.
		Ctenodonta beds.			
		Rhinidictya bed.			
	Stones River group.	Stictoporella bed			
		Vanuxemia bed.			
		'Lower Buff.'			
	Chazy formation	St. Peter Sandstone.			

Stony Mountain formation and Richmond group.

The limestones and shales at Stony Mountain contain a great number of fossil forms, many of them also found in both the Richmond group and the Utica group of Minnesota, and it is quite possible that if the section were complete at Stony Mountain, the upper beds with part of the shales beneath could be correlated with the Richmond group and the lower shales with the Utica.

Trenton of Manitoba and of Minnesota.

Of the Trenton group in Manitoba, the most striking dissimilarity to that to the south is the great increase in thickness. It comprises about three hundred feet of beds of limestones with very little shale, while in Minnesota, though the thickness varies considerably, the extreme thickness, or that given for Fillmore county is one hundred and fifty nine feet. The divisions adopted in Minnesota are based on the prevalence of certain typical forms of fossil remains found in each, and the beds so distinguished require careful examination to recognize. This method of subdivision seems necessary from the recurrence of beds of similar character throughout the section, but in Manitoba the divisions are made on broad distinctions in the general appearance of the beds, and are easily recognized in the Lake Winnipeg basin. The presence of nodules of chert in the Cat Head limestone is one but not the only distinguishing feature, and in comparing it with the section of the Fusispira bed of Prosser's ravine, near Wykoff, Minnesota, it is noticed that a thickness of nine feet is found having the same character. The fossils that distinguish the upper division of the Trenton in Minnesota are found distributed throughout the whole of the Trenton of Manitoba, and many of those of the lower divisions in Minnesota do not seem to be so characteristic of the same beds in the northern basin.

Winnipeg sandstone a basal formation.

The basal member, the Winnipeg sandstone, contains in its upper part shaly beds which in drill-holes elsewhere to the south-west in Manitoba are shown to become shale. The few fossils found are either representatives of forms in the Trenton above or occur, in Minnesota, in the Black River shales and occasionally in the Clitambonites beds, the lower division of the Trenton. The character of the deposit and that of the few fossil forms found, induces the belief that it represents the upper part of the Black River formation.

TRENTON PERIOD.

Various names given formations of of Trenton Period.

The limestones, which in Wisconsin are readily separated into two divisions, Galena and Trenton, become less distinct in Minnesota, and have caused considerable trouble in their correlation there. In many

papers and reports published by both the Minnesota and Canadian surveys, the Trenton has been referred to variously as the Galena, Galena-Trenton and Trenton. Beds now referred to the Black River group were assigned variously to the Upper Trenton and Upper Blue limestone and the Blue Carbon.

The limestones of Lake Winnipeg basin are referable to those previously called the Galena limestones. The latest designations for the Minnesota divisions are given in the Final Report of the Geological and Natural History Survey of Minnesota.*

In discussing the age of the Galena limestone, Prof. N. H. Winchell sums up by saying :— Age of Galena limestone.

'It may therefore be concluded that the Galena limestone is only a phase of the Trenton intensified in the typical region and fading out in all directions.

'It is a convenient designation in Iowa and some parts of Wisconsin and Illinois, but in Minnesota its convenience hardly warrants its continued use. The physical break and the faunal change which follows it in the North-west are probably parallels of those which mark the transition from the Trenton to the Hudson River (Utica slate) horizon, to which Mr. Walcott has called attention.'†

Similarly, in Manitoba, lithological distinction between the various beds can be traced as local variations, but they are not like those farther south. The whole series contains fossils common to all the beds, while lesser divisions seem to have, in addition, forms which characterize each horizon. Further research may help to widen the range of these latter species.

The three subdivisions proposed for the Trenton formation of Manitoba are made mainly on lithological distinctions, together with a prevalence of the typical forms of animal remains characteristic of each. Subdivisions of Trenton formation in Manitoba.

The upper part, consisting of 130 feet of light-yellowish mottled limestone, is found exposed at East Selkirk, Lower Fort Garry, and Selkirk Island at the north-western part of the lake, and will be discussed under the name of *Upper Mottled limestone.*

The central portion, consisting of homogeneous, generally fine-grained, yellow limestone, more or less magnesian, and containing cherty nodules scattered throughout its seventy feet of thickness, is discussed as the *Cat Head limestone*, from the locality at which they are best developed.

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* Vol. III, part 2.

† American Geologist vol. XV, No. 1, p. 33.

The lowest division is a dark-yellowish to grayish-white mottled limestone, found exposed along the more eastern points of the west side of the lake, and termed the *Lower Mottled limestone.* The thickness of this division amounts to about seventy feet.

List of fossils found in all divisions of Trenton formation.

As noted before, larger collections of fossils will doubtless greatly add to the lists here presented, and mainly to that given first for those forms which have a vertical range through all these divisions. The following lists have all been compiled from Palæozoic Fossils, Vol. III, Part III.

List of species known to range through the limestone beds of the Trenton formation of Manitoba :—

Receptaculites Oweni, Hall.
Pasceolus gregarius, Billings.
Halysites catenularia, L., var., *gracilis*, Hall.
Columnaria alveolata, Goldfuss.
Streptelasma robustum, Whiteaves.
Calapœcia Canadensis, Billings.
Strophomena trilobata, Owen.
Rafinesquina lata, Whiteaves.
Plectambonites sericea, Sowerby.
Orthis (Dinorthis) subquadrata, Hall.
" *testudinaria*, Dalman.
Platystrophia biforata, Schlotheim.
Rhynchotrema capax, Conrad.
" *inequivalvis*, Castelneau.
Salpingostoma Buellii, Whitfield.
Pleurotomaria muralis, D. D. Owen.
Hormotoma gracilis, Hall.
Maclurea Manitobensis, Whiteaves.
Trochonema umbilicatum, Hall.
Fusispira inflata, M. and W.
Endoceras subannulatum, Whitfield.
Actinoceras Bigsbyi, Bronn.
Actinoceras Allumettense, Billings.
Poterioceras nobile, Whiteaves.
Oncoceras Whiteavesii, Miller.
Trochoceras McCharlesii, Whiteaves.
Asaphus (Isotelus) Susæ, Whitfield.
" " *maximus*, Locke.
Illænus Americanus, Billings.
Bumastus Trentonensis, Clarke.

The Winnipeg sandstone.

General description.

The basal beds of the Cambro-Silurian of Manitoba consist of a series of soft friable sandstones, shaly in the upper part, but generally similar to those found in Minnesota beneath the Trenton limestone. Very few fossils have been obtained, and those from the upper part only, denoting merely lower beds of the Trenton. The following are the species found :—*Licrophycus Ottawaensis* (Trenton); *Serpulites dissolutus* (found also in the limestone above, at Punk Island); *Rhinidictya mutabilis* (Black River, at Minneapolis and St. Paul); *Escharopora ramosa* (Black River, at Minneapolis); *Strophomena trilobata* (also found in limestone above on Lake Winnipeg running to Upper Mottled limestone, and from middle beds of the Galena of Minnesota); *Orthis testudinaria* (runs through Trenton to Stony Mountain, in Manitoba); *Cyrtodonta Canadensis* (Trenton and Black River at Ottawa); *Aparchites Tyrrellii* (found only on Black Island), and also, an undetermined species of *Conularia.* The fossils give no definite information as to the age of the beds, but suggest a passage from Black River to Trenton.

Fossils found.

Shales of upper part, of Black River age.

In eastern Canada and New York state, the Black River is usually a thick-bedded limestone, but in Minnesota it is composed mainly of greenish shales; so that the shales below the limestone in the borings at Rosenfeld and Selkirk may be taken as the passage beds from the Black River. These are represented on Lake Winnipeg by shaly bands in the upper part of the section. The sandstone below, being in the nature of a shore-deposit, though occupying a position nearly similar to the St. Peter sandstone of Minnesota, can not be regarded as definitely of the same age, since no evidence of Chazy fossils has been found in it.

Thickness of formation.

The thickness of pure sandstone in the Lake Winnipeg basin is apparently much less than to the south. The several sections give varying thicknesses owing to the uneven nature of the floor on which it was deposited. Those at Grindstone Point show forty feet of beds, while the channel of the lake just in front of the exposure has been eroded by glacial action and kept clear by currents to a depth of fifty feet. This is probably not carried down to the lowest point in the Archæan floor, but, with the exposed section, probably represents ninety feet or more of easily eroded beds. At Dog Head, the base of the limestone is probably only a few feet below the lake-level, and the channel in the immediate vicinity has been eroded to a depth of ninety-six feet. On Black Island, exposures of similar beds form a nearly continuous section of about one hundred feet.

Thickness of formation.

If the plane formed by the base of the limestone beds capping the cliffs of Grindstone Point, Little Grindstone Point, Punk Island and Black Island were projected eastward, it would be found that a varying thickness of sandstones might exist beneath it, amounting in some cases to more than one hundred feet, but in others, along the east shore, to much less. It is also apparent that east and north of Dog Head the limestones must have been deposited immediately on the Archæan.

Lower beds.

The lower beds are exposed on the east end of Punk Island, and are there found to be soft, clean sandstone, stained in places by iron-oxide from underlying Huronian rocks. The upper beds are exposed in fine sections on Deer Island and along the north side of Grindstone Point, and show shale partings between the upper layers which are false-bedded. The shale predominates in the thin beds, which are from twenty-five to fifty feet below the top and correspond in general aspect at both the exposures. Westward and southward this upper part seems to be made up mainly of shales, and may be a continuation of those that in Minnesota hold Black River fossils.

Upper beds.

Lower Mottled limestone.

Lower Mottled limestone.

This division is the lowest member of the limestone series and rests directly on the basal sandstones and shales. These limestones form the principal part of the sections at Grindstone Point, Bull Head and Dog Head and on the islands north to Berens Island. The combined section given by these several exposures, amounts to a thickness of about seventy feet. The lowest beds are those seen at Deer Island and Grindstone Point capping the sandstone. Immediately above are the beds occurring at Dog Head, followed by the upper part of the Black Bear Island exposure. Those on Tamarack and Jack Head islands are evidently higher, but belong to the same series and form, together with those mentioned above, the following descending section :—

Distribution.

General section.

	Feet.
(1) Hard mottled limestone, dark-yellow, with brownish-yellow spots, breaking up into lumpy fragments not wearing discoidal on the beach but irregular. A few pieces from top beads are not so mottled and break smoothly (probably base of Cat Head limestone)	15
Exposure on west side of Jack Head Island.	
(2) Thin-bedded, mottled buff and grayish-white limestone, weathering ashy-white, in which are many large cephalopods : *Orthoceras*, *Sactoceras*, *Poterioceras*, *Oncoceras* and *Cyrtoceras*, while specimens of *Maclurea Manitobensis* and *Receptaculites Oweni* are abundant	15
Eleven feet of these beds are exposed on Little Tamarack Island and similar beds are exposed on Little Black Island near Berens Island.	

(3) Mottled limestone, buff-coloured but weathering lighter, in rather thicker beds than above and not so rich in fossils.......... .... These form the upper part of cliff on Black Bear Island.	10	General section.
(4) Thin beds of similar rock, rich in fossil remains......................... This band occupies the lower portion of the exposures on Black Bear Island, on Snake Island and Dog Head or Whiteway Point and the upper part of the cliffs of Bull Head and intervening exposures.	20	
(5) Darker, mottled, impure limestone, where not weathered, almost blue on fracture, fractures into thin flags with surfaces covered with fucoidal markings. The lower beds are of very earthy limestone resting on the sandstone of the basal series	10	
	70	

No. 5 is seen at the top of the exposures of sandstone on Deer Island, Punk Island, Grindstone Point and in the lower part of cliffs at Bull Head. The beds on the east end of Commissioner Island resemble this latter member and are probably an upward continuation of it.

The different beds enumerated in the above table are all very similar but can be recognized in the field. The line of division for the top is arbitrary and for convenience only. Between the three upper members there may be slight gaps, but they are thought to be of a few feet only, if any.

The fossils found, generally range through either the two lower divisions or through the whole series, but a few seem to characterize this division only, and from the table submitted it will be seen that the following as yet belong exclusively to the lower beds :—*Climacograptus bicornis*, *Solenopora compacta*, *Chætetes perantiqua*, *Serpulites dissolutus* (also found in sandstones immediately below), *Stomatopora Canadensis*, *Diplotrypa Westoni*, *Lingula Iowensis*, *Clitambonites diversa*, *Anastrophia hemiplicata*, *Rafinesquina Leda*, *Orthis pectinella*, *Platystrophia biforata* var., *crassa*, *Cyclospira bisulcata*, *Modiolopsis parviuscula*, *Vanuxemia Hayniana*, *Hormotoma Winnipegensis*, *Solenospira pagoda* var., *occidentalis*, *Trochonema niota*, *Loxonema Winnipegense*, *Actinoceras Canadense*, *Orthoceras Winnipegense*, *Ascoceras costulatum*, *Poterioceras gracile*, *Oncoceras magnum* var., *intermedium*, *Cyrtoceras Manitobense*, *C. laticurvatum*, *Eurystomites plicatus*, *Discoceras Canadense* and *Aparchites parvulus*. Of these the following are found in the Black River group of Minnesota :—*Solenopora compacta*, *Orthis pectinella*, *Solenospira pagoda* and *Trochonema niota*, while the following are found in the Trenton Group (formerly the Galena) :—*Lingula Iowensis*, *Clitambonites diversa*, *Anastrophia hemiplicata*, *Platystrophia biforata* var., *crassa*, *Cyclospira bisulcata*, and *Vanuxemia Hayniana*. Fossils found in this division only.

Cat Head Limestone.

Cat Head limestone.

The central portion of the limestone series, is best developed at the prominent point on the west side of Kinwow Bay, called Cat Head. The beds are of a fine-grained, evenly coloured, yellow dolomitic limestone, with numerous concretions of dark-coloured chert, filling cavities apparently left by the decay of corals. These beds are seen in the high cliff at Cat Head, and along the shore to Lynx Bay. At the western end of the section, three miles west of Cat Head, the cherty concretions attain large dimensions. Several are over a foot in length, and one measured two feet by ten inches, The lower beds are fine-grained, resembling lithographic stone and are very rich in fossil remains. The total thickness as observed on the lake is sixty-eight feet. This includes the top beds of Cat Head and Outer Sturgeon Island, which are similar in colour but coarser in texture, becoming finally crystalline. The section is made up as follows :—

General character.

General section.

	Feet.
(1) Hard, flinty, coarse-grained limestone (Sturgeon Island)................	10
(2) Yellow, granular limestone, weathering roughly and slightly honeycombed (Cat Head)..	8
(3) Similar coarse-grained, weathering dark-yellow, with fucoid-like markings, and very much honeycombed (Cat Head).....................	3
(4) Yellow limestone with fucoidal markings similar to No. (2) (Cat Head)..	10
(5) Fine-grained yellow rock with numerous ashy coloured spots scattered over the whole face of the exposure, from the weathering of small impure flinty concretions (Cat Head)................................	27
(6) Fine-grained yellow limestone, rich in fossil remains, with numerous large concretions of dark cherty material (Cat Head, McBeth Point and Inmost Island)..	10
	68

Distribution.

The area over which these beds might be exposed is in the form of a belt running parallel to the eastern outcrop of the Lower Mottled limestone. This would be in a NNW. and SSE. direction, but owing to the mantle of drift, these beds are exposed only in the typical localities and at the base of the cliffs north of the Saskatchewan River. They are recognized in the drillings from the Selkirk well where fine grained yellow limestone fragments, with about ten per cent of quartz, are supposed to represent the lower beds of this series, in which are found the flinty nodules noted above. Loose fragments of these rocks are found on the shore west of Big Island, on the islands in Fisher Bay, and on Reindeer Island, west of Cat Head.

Fossils found in this division only.

The fossil species found only in these beds, and probably characteristic, are :— *Chondrites* (*Bythotrephis*) *patulus*, *C. cuneatus*, *C. cupressinus*, *C. gracillimus*, *Aulacopella Winnipegensis*, *Trichospongia*

hystrix, Thamnograptus affinis, Lingula elongata, L. obtusa, Rafinesquina deltoidea, Zygospira recurvirostra, Palæopteria parvula, Ctenodonta astartæformis, C. subnasuta, Clinopistha antiqua, Rhytimya recta, Edmondia vetusta, Pleurotomaria margaritoides, Liospira persimilis, L. angustata, Trochonema eccentricum, Conularia asperata, Asaphus gigas, and *Bronteus lunatus.*

The two lower series—the Cat Head and the Lower Mottled—are not of any great thickness, but are in the district readily distinguished from each other. The dividing line is placed at a bed, at which the mottled limestone becomes highly charged with siliceous material in the form of chert nodules while the limestone above changes from a mottled grayish-white with darker spots, to a uniform buff, less crystalline rock. The faunal change is not very marked, but it will be noticed that the numerous large cephalopods that characterize the lower are almost altogether wanting in the middle division. In addition to the lists given for characteristic fossils of each of the divisions, the following forms are found to be common to both, but do not extend above them:—*Protarœa vetusta* var. *magna, Liospira Americana, Endoceras* (*Narthecoceras*) *Simpsoni,* and *Poterioceras apertum.*

Arbitrary line between two lower divisions

Upper Mottled limestone.

The most northerly exposure of this division is found in the cliffs on the western shore of the lake, north of the mouth of the Saskatchewan River. Here the beds are found to be highly dolomitic, and in consequence much harder than those of the same series in the south. The surfaces are found mottled in the same manner, and rough surface markings, as of fucoids, are also common on the bedding-planes. The volume of strata exposed is not very great, and the observed dip along the shore would seem to show that the total thickness here, thirty feet, would be shown on the cliff at the First Rocky Point. Probably a few feet of that from the south end of Selkirk Island should be added. On Selkirk Island, at the north end, a low cliff of hard dolomitic rock is found to contain a series of fossils similar in character to those found on the mainland, and is probably a continuation of these beds, while the highest rocks of this series in this locality are those at the southerly point of the island. There the rock is found very close-grained and hard or perhaps dolomitic. The colour is a dull-orange, and on glaciated or polished surfaces, a dark reddish-yellow. The few fossils brought from the locality, are badly preserved, but are mainly similar to those north.

Upper Mottled limestone.

Exposures on north-western shores of lake.

Section north of Saskatchewan River.

Section of division near Clark Point.

These beds appear to dip slightly to the south-west, and are probably immediately overlain by the shales of the Stony Mountain formation, but no exposures are seen from here to the Saskatchewan. Farther to the south, the section is slightly different, the lower beds of the mottled limestones there resemble those to the north, but higher up in the section the beds become darker in colour, and are impure earthy limestones, evidently passing up into the shales of the Stony Mountain formation. These lower beds are to be found at a point about nine miles north from Clark Point, and at Dancing Point. The latter are almost the exact counterpart of the Selkirk Island beds, but southward become more impure and darker in colour. In the section north of Clark Point, it is found that at the base, there is a few feet of a cherty, yellow fine-grained limestone exposed, which approaches the character of the Cat Head rocks, but this is possibly a thin band of that character, here found higher than the top of the second division. The upper beds are similar to the Clark Point limestone, which appears to form the upper member of the series and might be termed transition beds. The section at Clark Point is mainly of a yellowish-gray limestone, with several shaly bands. The top beds are much softer and of a clayey nature, often so soft as to be easily broken by the fingers. Near the mouth of Dauphin River they again appear in low flat exposures, but at the foot of the rapids they are exposed in low cliffs on each side of the river. Although these beds show little change in the faunal conditions as compared with the beds below, they seem to form the extreme top of the limestone series, and it may be found subsequently that they should be included in the lower member of the Stony Mountain formation.

Transition beds at summit of formation.

Beds of lower part at Fisher River.

On Fisher River the only beds seen, are near the mouth of the river and seem by their position, to be not far above the Cat Head, or near the base of the Upper Mottled limestones. They are light-coloured mottled limestone, very similar to that at East Selkirk. The mottling is in irregular patches of a light-brown, in a stone which is made up mainly of small calcite crystals and remains of shells, with fine chalk-like particles distributed freely throughout the mass. The stone is soft, breaking readily.

Exposures at Selkirk.

The same characters are repeated in the rocks of East Selkirk and Lower Fort Garry. The beds at the Selkirk quarry are found in a broken state and are probably near the edge of a pre-glacial trough extending south from the present shore of the lake and since filled in by drift- and river-deposit. No disturbance in the beds is seen at Lower Fort Garry. At West Selkirk the drift-deposit was found, in

drilling for a well, to extend to at least eighty feet below lake-level and the limestone is eroded to near the top of the Cat Head limestone. In the same drilling the base of these beds is supposed to be found eighty-eight feet deeper, and this thickness shows an increase of fifteen to eighteen feet over the sections on the lake, an increase which all the beds seem to receive south-westward from the outcrops. The measured section of the Lower Mottled limestone on the lake is here represented by eighty feet of limestone below what is taken as the base of the Cat Head limestone, showing an increase of about ten feet.

Increase in thickness of section westward.

The position then of the base of the Upper Mottled limestone would here appear to be one hundred feet below the top of the exposures at Lower Fort Garry and Selkirk. Of this thickness the upper part only, is exposed at the above localities, while of the lower part nothing is seen except what is probably represented by a few exposures near Fisher River.

Base of division ascertained at Selkirk.

From the depth at which the base of the limestone was found in the Selkirk well, in relation to the nearest known outcrop near Elk Island, the south-westward dip should be nearly the same as that at Grindstone Point. This dip will allow for the addition between Selkirk and Winnipeg of beds represented at Clark Point, probably the same as are shown at Bishop's quarry, near St. Andrews, where they are fine-grained, uniformly-coloured limestones. In estimating the total thickness of this division at one hundred and thirty feet, and adding below, that of the rock found in the well at Selkirk, we obtain two hundred and ninety-five feet as a total thickness for the Trenton. At Rosenfeld the measured thickness of this limestone band was three hundred and five feet, or slightly greater than to the north.

Thickness of division near Winnipeg.

In addition to the list already given, of fossils found in all three of the divisions of the Trenton, the following may be added as forms that are found as yet, in this upper division only :—

Fossils found in Upper Mottled limestone only.

Ischadites Iowensis, Owen.
Tetradium fibratum, Safford.
Diphyphyllum Stokesi, Edwards and Haime.
Pachydictya magnipora, Ulrich.
" *acuta*, Hall.
Phylloporina Trentonensis, Nicholson.
Monticulipora Wetherbyi, Ulrich.
Mesotrypa Selkirkensis, Whiteaves.
Bythotrypa laxata, Ulrich.
Strophomema rugosa, Blainville.

Strophomena Billingsii, Winchell and Schuchert.
Rhynchonella Anticostiensis, Billings (variety).
Byssonychia intermedia, Meek and Worthen.
Modiolopsis angustifrons, Whiteaves.
Orthodesma affine, Whiteaves.
Conocardium antiguum, D. D. Owen.
Pleurotomaria Stokesiana, Whiteaves.
Eunema strigillatum, Salter.
Endoceras (*Narthecoceras*) *crassiphonatum*, Whiteaves.
Actinoceras Richardsonii, Stokes.
" (*Deiroceras*) *Python*, Billings.
Orthoceras magnisulcatum, Billings.
" *anellus*, Conrad.
Tripteroceras Lambii, Whiteaves.
" *semiplanatum*, Whiteaves.
Oncoceras magnum, Whiteaves.
Aparchites Whiteavesii, Jones.
Calymene senaria, Owen.
Pterygometopus callicephalus, Hall.
Lichas (*Platymetopus*) *cucullus*, Meek and Worthen.
Lichas (*Conolichas*) *cornutus*, Clarke.

Stony Mountain formation.

Stony Mountain formation.

The deposits lying between the top of the Trenton and the base of the Silurian, attain a great thickness in Eastern Canada and New York. Westward, however, they are found in diminishing thickness to Cincinnati, where they still exceed eight hundred feet. The subdivisions assigned to the eastern beds are recognizable there, but northward from Ohio, owing to a continued diminution in thickness, some of the subdivisions disappear. In Minnesota they are described as having a thickness of only seventy feet. The lower division of the Cincinnati rocks, the Utica, with a thickness of twenty feet, is there recognized, consisting mainly of thin-bedded limestones and shales. The central division, the Lorraine group, is not recognized, and the upper division is described as being similar to those of the Richmond group or upper part of the Cincinnati section, and consists of arenaceous and argillaceous limestones, mainly thin-bedded.

Character and thickness of Cincinnati rocks.

Although this formation is supposed to thin out altogether in northern Minnesota, there is found at Rosenfeld, in the southern part, of Manitoba, a great thickness of shale beds between limestone for-

mations which are probably Trenton and Silurian. At Stony Mountain, the section, although incomplete, in a known thickness below the Silurian of one hundred and ten feet, consists of shaly beds in the lower part with thick-bedded limestones above. The fossils from this part are mainly from the shaly beds below the limestone of the top of the section, and probably all these are collected from less than fifty feet below the top of the formation. We might infer from this that the upper part, that of which we have a section and a list of fossils, is referable to the Richmond group of Minnesota, and that the lower beds, mostly shales, are similar to the Utica of the Cincinnati formation. One species only, characteristic of the Utica of Minnesota has been found at Stony Mountain—*Primitiella unicorns*, Ulrich. The majority of those common to the two localities are from the upper parts of the sections. It is noted in the Minnesota reports that several forms occurring in the Trenton, appear in the Richmond group without any evidence of their presence in the Utica. The same might possibly be asserted of some of the Manitoba forms, as several are found to range from the Trenton to the Stony Mountain formation.

Thickness of section at Stony Mountain.

Age of beds.

The only outcrops in Manitoba of rocks of Cincinnati age, appear to be in the vicinity of Stony Mountain and Little Stony Mountain, but their presence elsewhere is proved by bore-holes, showing that they extend from Stonewall south-eastward to the vicinity of the city of Winnipeg. Their continuation southward probably occupies a band now heavily drift-covered, since their presence is demonstrated, as before noted, in the section drilled at Rosenfeld. Northward, no exposures are seen, the outcrop being hidden. The basin in which Lake St. Martin is situated is eroded through Silurian rocks, and it is found that the beds below belong probably to the Trenton, which lies on an elevation of the Archæan floor, as bosses of granite and trap protrude through. The Stony Mountain rocks are evidently here wanting, and if they outcrop northward the band is much thinner than to the south. At the Grand Rapids of the Saskatchewan the Silurian beds are found near the mouth of the river, and but a short distance eastward, the upper beds of the Trenton appear, so that the interval would allow of only a thin band to be interposed, but no outcrops of recognizable Stony Mountain formation are seen. A few beds near the mouth of the War-path River appear to be above the Trenton and somewhat similar to the upper part of the Stony Mountain, but the absence of fossils leaves the age somewhat uncertain. Crossing the Little Saskatchewan River at Four-mile Rapid, Dr. Bell records shales holding *Rhynchonella capax*, but as this species is found

Distribution in Manitoba.

in the Trenton, the Stony Mountain age of these beds is also doubtful, since nearly similar rocks at the mouth of the river and at Clark Point have an extensive Trenton fauna.

Compilation of list of fossils.

A list of all the fossil forms so far obtained from the beds of Stony Mountain, as well as from the exposures of the Trenton and Black River of Lake Winnipeg, has been compiled from the palæontological reports of the Survey and arranged in tabular form so as to show the horizon of their occurrence and give a comparative view of the fauna of the Cambro-Silurian of the Manitoba basin.*

LIST OF FOSSILS FROM THE CAMBRO-SILURIAN OF MANITOBA.

		Trenton (Galena.)			Richmond group. (Cin.)
——	Passage beds at top of sandstone.	Lower mottled limestone.	Cat Head limestone.	Upper mottled limestone.	Stony Mountain.
ALGÆ.					
Licrophycus Ottawaensis, Billings	*				
Chondrites (*Bythotrephis*) *patulus*, Whiteaves			*		
" " *cuneatus* "			*		
Chondrites cupressinus, Whiteaves			*		
" *gracillimus*, Whiteaves			*		
Bythotrephis (like *B. succulens*, Hall)					*
RECEPTACULITIDÆ.					
Receptaculites Oweni, Hall		*		*	
Ischadites Iowensis, Owen				*	
Pasceolus gregarius, Billings		*	*	*	
PORIFERA.					
Aulacopella Winnipegensis, Rauff			*		
Trichospongia hystrix, Whiteaves			*		
CŒLENTERATA.					
Hydrozoa.					
Climacograptus bicornis, Hall		*			
Thamnograptus affinis, Whiteaves			*		
Inocaulis Canadensis, Whiteaves			*	*	

*Palæozoic Fossils, vol. III., parts II. and III., by J. F. Whiteaves, F.G.S., F.R.S.C.

LIST OF FOSSILS FROM THE CAMBRO-SILURIAN OF MANITOBA.

—	Passage beds at top of sandstone.	Trenton (Galena.)			Richmond Group (Cin.)
		Lower Mottled limestone.	Cat Head limestone.	Upper Mottled limestone.	Stony Mountain formation.
ACTINOZOA.					
Alcyonaria.					
Halysites catenularia, Linn, var. *gracilis*, Hall	......	*	*	*	....
Tetradium fibratum, Safford	......	......	......	*	....
Zoantharia.					
Columnaria alveolata, Goldfuss	......	*	......	*	......
Diphyphyllum Stokesi, Edwards and Haime	......	......	......	*	....
Streptelasma robustum, Whiteaves	......	*	....	*	....
" *rusticum*, Billings	......	......	......	......	*
" " var. *trilobatum*, Whiteaves	......	......	......	......	*
Protaræa vetusta, Hall	.....	*	......	.	*
" " var. *magna*, Whiteaves	.....	*	*	......	....
Favosites prolificus, Billings	......	......	......	*	*
Calapœcia Canadensis, Billings	......	*	....	*	*
Hydromedusæ.					
Beatricea undulata, Billings	......	......	......	......	*
" *nodulosa*, Billings	......	......	......	......	*
Unclassified.					
Solenopora compacta, Billings	......	*	......	......	....
Chætetes perantiquus, Whiteaves	......	*	......	......	....
ECHINODERMATA.					
Crinoidea.					
Glyptocrinus ramulosus (?) Billings	......	......	......	......	*
" sp. undeterminable	*	*	*	......	....
Cystoidea.					
Glyptocystites, sp. undeterminable	......	*	......	......	....
Asteroidea.					
Tæniaster, sp. undeterminable	......	......	*	......	....
VERMES.					
Annelida.					
Serpulites dissolutus, Billings	*	*	......	......	....
Arabellites, sp. undetermined	......	*	......	......	....

LIST OF FOSSILS FROM THE CAMBRO-SILURIAN OF MANITOBA.

—	Passage beds at top of sandstone	Trenton (Galena.)			Richmond group (Cin.)
		Lower Mottled limestone.	Cat Head limestone.	Upper Mottled limestone.	Stony Mountain formation.
MOLLUSCOIDEA.					
Polyzoa.					
Rhinidictya mutabilis, Ulrich	*				
" *obliqua*, Ulrich	*				
Escharopora ramosa, Ulrich	*	*			
Stomatopora Canadensis, Whiteaves					*
Proboscina auloporides, Nicholson					*
" *frondosa*, Nicholson					*
Monticulipora parasitica, var. *plana*. Ulrich					*
Homotrypella gracilis, Nicholson					*
Bythopora delicatula, Nicholson					*
" *striata*, Ulrich					*
Petigopora scabiosa, Ulrich					*
Monotrypella quadrata, Rominger					*
Batostoma Manitobense, Ulrich					*
Arthroclema angulare, Ulrich					*
Helopora Harrisii, James					*
Sceptropora facula, Ulrich					*
Ptilodictya Whiteavesii, Ulrich					*
Dicranopora fragilis, Billings					*
" *emacerata*, Nicholson					*
Goniotrypa bilateralis, Ulrich					*
Pachydictya hexagonalis, Ulrich				*	
" *magnipora*, Ulrich				*	
" *acuta*, Hall				*	
Phylloporina Trentonensis, Nicholson				*	
" sp. undetermined				*	
Monticulipora Wetherbyi, Ulrich					*
" *parasitica* var. *plana*, Ulrich				*	
Mesotrypa Selkirkensis, Whiteaves		*			
Diplotrypa Westoni, Ulrich				*	
Bythotrypa laxata, Ulrich					
Brachiopoda.					
Lingula Iowensis, Owen		*	*		
" *elongata*, Hall			*		
" *obtusa*, Hall				*	*
Dinobolus parvus, Whitfield					*
" sp. undeterminable		*			
Clitambonites diversa, Shaler		*			
Anastrophia (?) *hemiplicata*, Hall			*	*	*
Strophomena incurvata, Shepard					*
" *fluctuosa*, Billings				*	
" *rugosa*, Blainville	*	*		*	
" *trilobata*, Owen				*	
" *Billingsii*, Winchell and Schuchert			*		
Rafinesquina deltoidea, Conrad					*
" *Ceres*, Billings			*	*	
" *alternata*, Emmons		*			
" *Leda*, Billings					

LIST OF FOSSILS FROM THE CAMBRO-SILURIAN OF MANITOBA.

—	Passage beds at top of sandstone.	Trenton (Galena). Lower Mottled limestone.	Trenton (Galena). Cat Head limestone.	Trenton (Galena). Upper Mottled limestone.	Richmond Group (Cin.) Stony Mountain formation.
MOLLUSCOIDEA—*Con.*					
Brachiopoda—*Con.*					
Rafinesquina lata, Whiteaves		*	*	*	
Leptæna unicostata, M. & W.			*	*	
" *nitens*, Billings					*
Plectambonites sericea, Sowerby		*	*	*	
Orthis tricenaria, Conrad		*	*		
" *pectinella*, Hall		*			
" (*Dinorthis*) *subquadrata*, Hall		*		*	
" " *proavita*, W. & S.				*	*
" (*Dalmanella*) *testudinaria*, Dalman	*			*	*
Platystrophia biforata, Schlotheim		*		*	
" " var. *crassa*, James		*			
Rhynchotrema capax, Conrad		*		*	*
" *inequivalvis*, Castelneau		*	*		?
Rhynchonella Anticostiensis, Billings					*
" " variety				*	
Zygospira recurvirostra, Hall			*		
Cyclospira bisulcata, Emmons		*			
MOLLUSCA.					
Pelecypoda.					
Byssonychia obesa, Ulrich					*
" *intermedia*, M. & W				*	
Plethocardia (sp. nov.)					*
Palæopteria parvula, Whiteaves			*		
Modiolopsis parviuscula, Billings		*			
" *angustifrons*, Whiteaves				*	
Orthodesma affine, Whiteaves				*	
Vanuxemia Hayniana, Safford		*			
Ctenodonta astartæformis, Salter			*		
" *subnasuta*, Ulrich			*		
Cyrtodonta Canadensis, Billings	*				
Clinopistha antiqua, Whiteaves			*		
Rhytimya recta, Whiteaves			*		
Conocardium antiquum, D. D. Owen				*	
Edmondia vetusta, Whiteaves			*		
Gasteropoda.					
Tetranota bidorsata, Hall			*	*	
Salpingostoma Buellii, Whitfield		*		*	
Conradella, sp. uncertain				*	
Pleurotomaria bicincta, Hall					*
" *muralis*, D. D. Owen		*		*	
" *acuta* (?) Sowerby					*
" *Stokesiana*, Whiteaves				*	
" *margaritoides*, Whiteaves			*		

LIST OF FOSSILS FROM THE CAMBRO-SILURIAN OF MANITOBA.

—	Passage beds at top of sandstone.	Trenton (Galena.)			Richmond group. (Cin.)
		Lower Mottled limestone.	Cat Head limestones.	Upper Mottled limestone.	Stony Mountain formation.
MOLLUSCA—*Con.*					
Gasteropoda—*Con.*					
Liospira Americana, Billings	...	*	*	...	...
" *persimilis*, Ulrich and Scofield	...	...	*	...	...
" *angustata*, Ulrich and Scofield	...	...	*	...	...
Hormotoma gracilis, Hall	...	*	...	...	*
" *Winnipegensis*, Whiteaves	...	*	...	...	...
Murchisonia bellicincta, Hall	...	*	...	...	...
Solenospira pagoda, (Salter), var. *occidentalis*, Whiteaves	*	...	...	...	...
Bellerophon bilobatus, Sowerby	...	...	...	...	*
Cyrtolites compressus, Conrad	...	...	...	*	*
Cyclora minuta, Hall	...	...	...	...	*
Maclurea (*Maclurina*) *Manitobensis*, Whiteaves	...	*	*	*	...
Trochonema umbilicatum, Hall.	...	*	...	*	*
" *eccentricum*, U. & S.	...	...	*	...	...
" *niota*, Hall	...	*	...	...	...
Eunema strigillatum, Salter	...	...	...	*	...
Subulites, sp. undetermined	...	...	...	*	...
Fusispira inflata, M. & W.	...	*	...	*	...
" *elongata*, Hall	...	...	...	*	...
Loxonema Winnipegense, Whiteaves	...	*	...	...	...
PTEROPODA.					
Conularia asperata	...	...	*	...	...
" sp. undetermined	*	...	...	...	...
CEPHALOPODA.					
Endoceras subannulatum, Whitfield	...	*	*	*	...
" *(Narthecoceras) crassisiphonatum*, Whiteaves	...	...	...	*	...
" " *Simpsoni*, Billings	...	*	*	...	...
Actinoceras Richardsonii, Stokes	...	...	...	*	...
" *Bigsbyi*, (?) Bronn	...	*	*	*	...
" *Allumettense*, Billings	...	*	...	*	...
(*Deiroceras*) *Python*, Billings	...	...	...	*	...
" (*Sactoceras* ?) *Canadense*, Whiteaves	...	*	...	...	...
Orthoceras Winnipegense, Whiteaves	...	*	...	...	...
" *magnisulcatum*, Billings	...	...	...	*	...
" *Selkirkense*, Whiteaves	...	...	...	*	*
" *anellus*, Conrad	...	...	...	*	...
Tripteroceras Lambii, Whiteaves	...	...	...	*	...
" *semiplanatum*, Whiteaves	...	...	...	*	...
Ascoceras costulatum, Whiteaves	...	*	...	...	...
" sp. undetermined	...	...	...	...	*
Poterioceras nobile, Whiteaves	...	*	...	*	...
" *apertum*, Whiteaves	...	*	*	...	...

LIST OF FOSSILS FROM THE CAMBRO-SILURIAN OF MANITOBA.

—	Passage beds at top of sandstone.	Trenton (Galena.)			Richmond group. (Cin.)
		Lower Mottled limestone.	Cat Head limestone.	Upper Mottled limestone.	Stony Mountain formation.
CEPHALOPODA—*Con.*					
Poterioceras gracile, Whiteaves		*			
Oncoceras magnum, Whiteaves				*	
" " var. *intermedium*		*			
" *Whiteavesii*, Miller		*	*	*	
Cyrtoceras Manitobense, Whiteaves		"			
" *laticurvatum*, Whiteaves		*			
Eurystomites plicatus, Whiteaves		*			
Discoceras Canadense, Whiteaves		*			
Trochoceras (?) *McCharlesii*, Whiteaves		*		*	
Litoceras insigne, Whiteaves					*
CRUSTACEA.					
Ostracoda.					
Aparchites Whiteavesii, Jones				*	
" *parvulus*, Jones		*			
" *Tyrrellii*, Jones	*				
" *minutissimus*, Hall					*
Leperditia subcylindrica, Ulrich					*
Primitiella unicornis, Ulrich					*
Primitia lativia, Ulrich					*
" (*Beyrichia* ?) *parallela*, Ulrich					*
Eurychilina Manitobensis, Ulrich					*
Tetradella quadrilirata var. *simplex*, Ulrich					*
" *lunatifera*, Ulrich					*
Trilobita.					
Calymene senaria, Owen				*	
" *callicephala*, Green					*
Asaphus (*Isotelus*) *Susæ*, Whitfield		*	*	*	
" " *gigas*, DeKay			*		
" " *maximus*, Locke		*	*	*	
Illænus Americanus, Billings		*	*	*	
Bumastus Trentonensis, Clarke		*		*	
Bronteus lunatus, Billings			*		
Pterygometopus callicephalus, Hall				*	*
Cheirurus pleurexanthemus, Green			*	*	
" *Icarus*, Billings					*
Staurocephalus, sp. undeterminable				*	
Lichas (*Platymetopus*) *cucullus*, M. & W				*	
Encrinurus raricostatus, Walcott					*
Lichas (*Conolichas*) *cornutus*, Clarke				*	
Harpes, sp. undeterminable		*			

DESCRIPTIVE GEOLOGY.

Trenton Period.

Winnipeg sandstones and shales.

Sandstone near Elk Island.

The first exposures of the Winnipeg sandstone on the southern part of the lake, in Traverse Bay, on the eastern side of the Elk Island peninsula, have been described by Mr. Tyrrell. They are on section 36, Tp. 19, R. VII, where the banks rise to a height of thirty feet. His notes are as follows:—'The top, for about six feet, is composed of a sandy till, with large and small boulders, having the appearance of a ground moraine. Lying unconformably below this is a soft light-gray or brown sandstone, generally rather fine and arenaceous, but in places coarse, and fairly evenly bedded throughout. The exact thickness of this was not seen, but it would appear to extend down to the water. This cliff extends along the shore for about half a mile.'

Elk Island.

Other exposures are noted on the north-west shore of Elk Island. The following note refers to a point about midway along the face of this island:—'Bank fifty feet high (measured). From thirty to forty feet is seen to be composed of fine white sand, while the upper five feet is of stratified sand and pebbles, evidently alluvial. The rest of the bank is covered with slidden material. The fine white sand which is thinly and horizontally bedded is doubtless the Winnipeg sandstone. This is seen in many small exposures on the face of the slide-covered cliff, and is composed of interstratified white and light-brown, soft, clayey sandstone.'

Outlier on Clement Point

A small outlier is also recorded by Mr. Tyrrell on Clement Point, or on the northern shore of the bay at the mouth of Bad-throat River.

Black Island.

The shores of Black Island afford many sections which are recorded in his field-notes. From a perusal of his descriptions of the shores of this island it is seen that the Winnipeg sandstones occupy nearly the whole of the island, with the exception of a small area at the eastern end. The Trenton limestone possibly forms a thin covering for the greater part, as occasional slabs are found on the beach. Sections showing the presence of sandstone, occur on both sides of the island. The section which shows probably the lowest beds occurs on the north side, about three and a half miles from the eastern end and is as follows:—

'The shore is sandy, with many boulders, among which are many small rounded fragments of coarse granular or vesicular iron-ore. At this spot is a very interesting section from the surface downward as follows:— Section on north shore Black Island.

	Feet.	Inches.
Yellow and red ferruginous swamp-deposit containing *Planorbis parvulus*, etc.	1	0
Horizontally stratified and undisturbed, blue-gray clay, without pebbles	3	0
Very much disturbed clay, part being well stratified. At the bottom tongues of sand run up into it, and it is underlain by the same sand. Both sand and clay contain pebbles	2	0
Covered	3	0
Horizontally stratified white or light-yellow soft sandstone of moderately even grain.		
In a few yards the clay and pebbles shown above run out and the whole is replaced by soft white horizontally bedded sandstone	12	0
	21	0

'Just east of the point this is seen to be underlain by harder, yellow, very coarse sand or fine conglomerate.'

On the south side of the island, almost directly across, another section is exposed, in which thirty-one feet of sandstone is seen. At about the middle of the south side, to the east of the iron-ore deposit, the following section is recorded:— Section on south side.

	Feet.	Inches.
Surface deposit	2	0
Rounded gravel	0	6
Till, differing little from the sandstone below, except that the bedding in places is destroyed and it is filled with pebbles and boulders	8	0
Soft white or light-yellow sandstone	3	0
Moderately hard white sand, the surface of which is weathered and very soft	15	0
Covered, to water edge	15	0
	43	6

On the north shore, to the east of the mining claim laid out there, about midway along the shore, but nearer the eastern end of the island, the following section is noted:— Exposures on north shore.

'The cliff behind, which is higher than that farther east, is here thirty feet high and is composed as far as can be seen of light-yellow and white, soft sandstone in horizontal beds, capped by a few feet of mixed up sandstone containing boulders. Sandstone is also seen along the edge of the water, thus giving in all a thickness of about twenty-five feet.'

The shore in view of Gull Harbour on Big Island, affords many examples of small exposures of the soft sandstones. None of them seem to be of great thickness, and the probability is that the base of the Trenton is not far above lake-level, and that the strait between the two islands, which is eroded to such a great depth, mainly by current action, is through the soft sandstones. The depth, forty-two feet, may be through the greater part of the section here, though toward the eastern end of Black Island, the surface, back from the shore, rises to ninety feet, and is probably all sandstone with a light cap of limestone. The only section showing the limestone in place capping the sandstone, is at a point one mile from the south-west point on the south shore. The section recorded in Mr. Tyrrell's notes is as follows :—

Erosion of channel through sandstone.

Section of sandstones near western point.

	Feet.	Inches.
Gray, mottled Trenton limestone in thick beds, somewhat slidden but evidently in place	4	0
A little soft gray sand is stuck to the bottom corner of the limestone slabs.		
Covered	8	0
Dark bottle-green soft earthy shale containing near the top concretionary masses of hard clear quartzose sand	4	0
Soft brown sand	0	9
Blue sandy clay	0	1
White or light-green hard sandstone, much broken, weathering light-yellow and smelling strongly of sulphur, in places tinted brown with iron	3	0
Soft, light-blue sandy clay	0	11
Thick-bedded sandstone, brown and hard enough to break off in pieces but the bottom part soft and white	6	0
Covered, to water	14	0
	40	9

Two hundred yards farther east similar sandstones are seen extending down to within six feet of the edge of the water.

Sandstone on Big Island.

On the northern end of Big Island the sandstones are exposed just below the limestone bed, but the face of the exposure is generally covered by débris, so that the section can not be given in detail. The height of the dividing line between the two formations, was found to be at twenty-five feet above the water. Owing to a dip to the south-west, these beds are not again exposed on this island.

Deer Island.

The exposures on Deer Island are best seen on the northern face, but as the eastern side was visited by Prof. H. Y. Hind, the exposures there seen will be described first. On the eastern face of the north-east point, there is a sloping exposure of sandstone and shale, showing the following beds in ascending order :—At the beach there is about three feet of soft sandstone, the hardest in the exposure.

This is in beds eighteen to twenty inches in thickness, the colour is generally light, but a good deal stained with iron—exposed surfaces weathering dull brown. Above this, for fifteen feet, are thin streaky beds of sandstone, separated by shale, generally green and black, giving the whole a mottled look—a mixture of yellow, red, green and white. All these shales and sandstones crumble in the hand, having little consistency, and grade upward into darker beds with less sand and more shale, forming a band of five feet of dark shaly beds. Above the dark band, purer sand-beds with little shale, have a thickness of seven feet, making in this exposure a section in all of about twenty-eight feet About the middle of the north-eastern shore, the soft sandstones of the upper part are all denuded away, leaving only the lower harder beds. By a slight flexure in the rocks, these lower beds are raised three or four feet, so that six or seven feet in all are there exposed, and some large blocks have been quarried out for building purposes Owing to the softness and uncertain strength of this stone, none of it seems to have been used, morcover, the rusty streaks, caused by the decomposition of the pyrites often contained, renders it unsightly. The preservation of animal remains has been very imperfect, but on some surfaces a few impressions as of lamellibranchs are seen. Branching stems, or forms resembling plants, are very abundant in nearly all the beds.

Section on north-eastern face.

Quarry.

At the northern point there is the same section slightly modified and with an addition of about fifteen feet of limestone lying conformably on the sandstone. The section near the point is as follows :—Fifteen feet of thick-bedded limestone splitting into rectangular slabs from one to six inches in thickness, lying upon about five feet of a yellow friable sandstone in rather thin beds. Below this the beds get thinner and the shaly partings give them a darker appearance. The section described by Prof. H. Y. Hind in 1859, must have been of the cliff at or near this point. His description which is very minute, is as follows :—*

Section at northern point

Section recorded by H. Y. Hind.

'Lake-level.

'Shingle Beach, (Limestone.)

'No. 1. Four feet of dark-green argillo-arenaceous shale, with thin layers of sandstone of uneven thickness—Fucoids very abundant in the sandstone. The weathered sandstone is reddish-brown; fresh surfaces are white or gray. White iron-pyrites assimilating the forms of disks, spheroids and shells occurs in the sandstone.

'No. 2. In many respects like the former; the sandstone layers are from one to four inches in thickness and predominate over the shaly

* Report of the Saskatchewan Exploring Expedition by H. Y. Hind, M.A., p. 86.

Section by H. Y. Hind.

portions. Its thickness is six feet. The character of these formations (1 and 2) is very variable; the green argillaceous portion sometimes predominates, and occasionally the sandstone.

'No. 3. Ten feet of sandstone with green bands of a soft argillaceous rock, from one quarter to four inches in thickness. The sandstone is often white, but generally red. A persistent green band, a few inches thick, filled with obscure forms, resembling fucoids is very characteristic. The red coloured sandstone is often soft and friable, the white frequently embodied in the red. Both red and white, contain obscure organic forms. The green patches which are found throughout the sandstone, contain impressions of fucoids; an *Orthoceratite* was found in the sandstone. In some parts of the exposure on Deer Island the sandstone layers are much harder, although partaking of the characters already described. When thus hard, the white portion is extremely brilliant, of a pure white, and very siliceous, it would form an excellent material for the manufacture of glass. Forms coloured brown, often pervade the white sandstone, and appear to resemble fucoids and corals replaced by brown ochreous sand.

'No. 4. Eighteen feet of limestone, perfectly horizontal, very hard and breaking off the cliff where the soft sandstone has been weathered away, in huge rhomboidal slabs, eight to twenty-five feet in diameter and four to ten inches thick.'

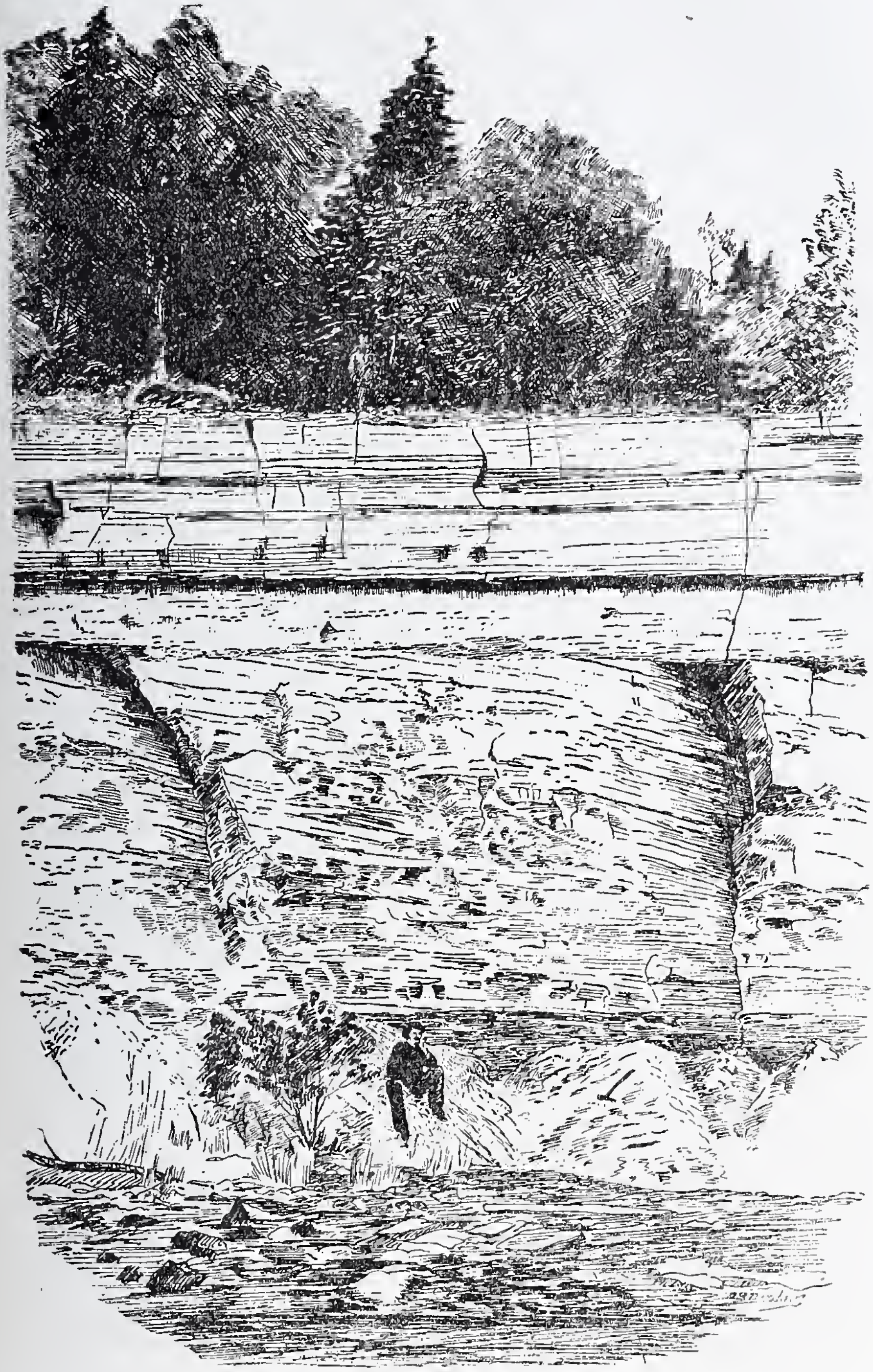
North-western face of Deer Island.

The north-western face of the island is by far the most interesting as it is quite free from detrital material, the cliff being precipitous and showing a good section to the top of the beach. The limestone capping it, is as before noted, about eighteen feet thick at the northern point, but thins somewhat to the south-west, showing less than ten feet of beds at the western end. This has been caused by the denudation of some of the upper beds.

Section on north side.

About the middle of the exposure where a section was measured, the thickness is ten feet. Below this a bed of yellow sandstone, very friable, three feet in thickness, lies horizontal and perfectly conformable to the limestone. Below this, false-bedding gives an appearance of unconformity. The beds dip away quite sensibly to the south-west. They are thin and of a yellow sandstone, with traces of shaly partings. Each bed dips away from the upper horizontal line, making an angle with it of from eight to ten degrees. Following a bed downward, it thins out gradually and the dip becomes less, so as to form a slight curve, and when it has descended about seventeen feet, it has about regained the horizontal position.

This thinning out without loss of shale, results in a series of thin-bedded shaly sandstones, two or three feet answering well the description by Hind of No. 2. The upper part contains less shale and shaly Section on north side Deer Island.



SECTION ON DEER ISLAND, SHOWING FALSE BEDDING IN SANDSTONE.

Section on north side Deer Island.

bands, than described by Hind, and is no doubt due to a slight change in these false-bedded bands farther north along the section. Hind's section was observed at the northern end of the island, at nearly right-angles to this one, and would consequently not show the false-bedding. Here the proportion of shale increases from the top. The general colour of the lower half of the section is a dark-yellow, with streaks of red, blue and green. Above, it is of a lighter yellow, with a few rusty spots and small patches weathered ashy white, fresh fractures appearing less stained with red, and of a light chrome-yellow. At the base of this sandstone are two feet of a dark shale with sandy streaks. The shale is green or black. It is all soft, easily crumbled in the hand, and is in no part free from sand. A thin bed of dark sandstone, averaging a foot in thickness lies below. This is a harder bed than any in the section above, except the limestone, but it is, still a soft sandstone. Dark sandy shales again appear, adding about three feet more to the section.

The top was forty-one feet six inches above lake-level, in September, 1891-bottom of limestone and top of sandstone thirty-one feet six inches-bottom of three-foot bed of sandstone, and top of false-bedding, twenty-eight feet six inches. False-bedding extends down for about seventeen feet, and at a point eleven feet six inches above lake-level, has about regained the horizontal stratification of the upper beds. About nine feet six inches above water, the shaly beds overlie a sandstone layer of varying thickness. The top of the beach averages four feet six inches above the lake.

The shore facing the south-west shows no exposure of this sandstone. On the small island to the west, sandstone and shales are exposed, with a predominant green colour. This is evidently the same as the lower part of the section just described, the beds being here nearly horizontal.

Fossils.

Fossils collected from the sandstones of Deer Island :—*Licrophycus Ottawaensis*, *Serpulites dissolutus*, *Rhinidictya mutabilis*, *Escharopora ramosa*, *Strophomena trilobata*, *Orthis testudinaria*, and *Conularia* (sp. undeterminable).

Punk Island.

On Punk Island the total thickness of this sandstone is nearly one hundred feet. The western half of the island is capped by the limestone, as on Deer Island, dipping to the south-west, forming a sloping plane, broken on its eastern edge by the denudation of the limestone. The eastern part, being made up almost wholly of the sandstone, is irregular and at a lower level. At the eastern end, the sandstone is ound resting on the Archæan. No actual contact is seen, but the

small islands immediately off the point, are found to be Huronian. The sandstone here is generally light coloured and very friable, but sometimes are darkly stained with iron, presumably from deposits of iron-ore, immediately beneath. The exposures on the north side are mostly covered by great slabs of limestone, fallen from above, but in the shaly beds many fossil forms were collected. Among the more common the following forms were identified by Dr. Whiteaves :—*Licrophycus Ottawaensis*, *Glyptocrinus* (sp. idnt.), *Serpulites dissolutus* (sp. indt.), and a *Conularia*.

On the mainland to the north, this sandstone underlies the points on the western side of the lake to near Dog Head.

Little Grindstone Point.

At Little Grindstone Point the overlying limestone is at an elevation of about seven feet above the water, so that very little of the sandstone is seen. The section observed consisted of two feet of fucoidal sandstone, showing above the beach. Indications of fossils are seen in this, and from a few loose blocks of the lowest bed several specimens of *Cyrtodonta Canadensis* were collected. The upper part of the section consists of eighteen inches of thin-bedded sandstone and shales immediately below the limestone.

Grindstone Point section of sandstone.

The exposure eastward to Grindstone Point continues to increase in height, and at the extreme point the following descending section was measured :—

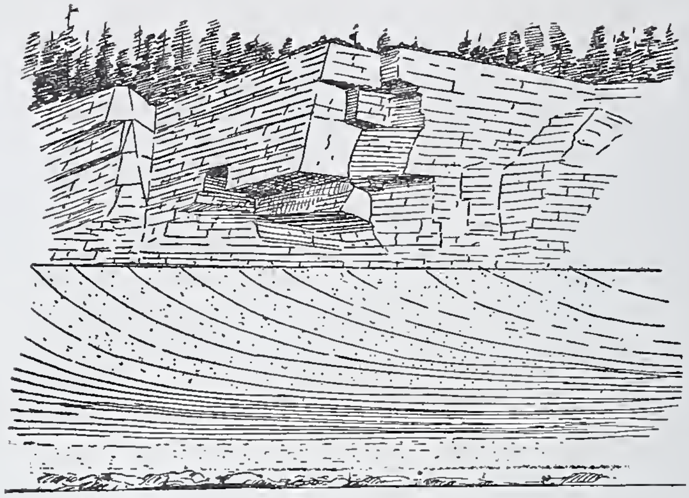
	Feet.	Inches.
Limestone, dark, mottled	5	6
Yellow friable sandstone	2	5
Greenish sandy shale	2	0
Soft yellow sandstone	4	0
A series of thin beds of sandstone averaging 2 in. with shaly partings, giving the whole a variegated appearance, colours green, yellow and white	10	0
Soft sandstone, full of small nodules of harder rock, stains rusty red	13	0
Dark sandy shale, green brown and red	1	0
Dark-brown ferruginous sandstone harder than any above	3	0
At water's edge, light-yellow sandstone harder than in section above.		
	40	11

Fossils.

From this exposure of thirty-five feet of sandstone a few fossil forms have been collected. Dr. Whiteaves recognizes the following:—*Licrophycus Ottawaensis*, *Glyptocrinus*, and *Cyrtodonta Canadensis*.

False-bedding.

Westward along the north side of the point, the section resembles that of the north side of Deer Island, but the false-bedding noted there, is continued to the top of the sandstone in the Grindstone Point exposure, as shown in the cut on next page.



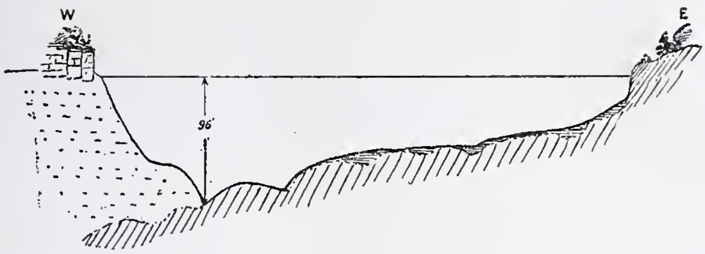
SKETCH-SECTION ON NORTH SIDE OF GRINDSTONE POINT; LIMESTONE BEDS RESTING ON FALSE-BEDDED SANDSTONE.

Sandstone exposed near Bull Head.

On the north side of Washow Bay, these sandstones are exposed in several places from near Little Bull Head northward. The exposure at Little Bull Head, three miles south of Bull Head, is at the base of a high escarpment rising sixty feet above the lake, showing limestone at the top. Débris covers the face to about twenty-five feet from the water-line, where two feet of blue and green shales lie on the top of thick sandstone beds. The upper bed is marked by numerous harder portions resembling the fucoid impressions common in the limestones above. Red and yellow sandstones, very friable, occupy the rest of the section. The top of the fucoidal sandstone bed is here twenty-two feet above the water, and is again seen near Bull Head at eight feet, and within half a mile of Bull Head at five feet above the lake. The limestone resting on these soft rocks is broken by vertical cleavage-planes, and sometimes displaced, but the base would appear to be at about nineteen feet above the fucoidal bed, making with the section at Little Bull Head a thickness here exposed of about forty-one feet.

Fissures in limestone.

Following the shore northward to Dog Head, there is abundant evidence that the limestone exposed all along, rests on these very soft beds. Everywhere great blocks are broken off and have partially slidden down toward the water. An estimate can be occasionally had of the thickness of the limestone exposed, so that the surface plane of the sandstone is estimated to lower to the north until it reaches the water-level near Dog Head.



SECTION ACROSS CHANNEL AT DOG HEAD.

A section, made by soundings, shows a probability of there being about one hundred feet of soft beds below the limestone, resting on the sloping floor of the Archæan rocks. Thickness of section at Dog Head.

Lower Mottled limestone.

The lower beds of the Trenton are exposed along the eastern edge of the outcrop of the Cambro-Silurian in this basin, from Berens Island southward to Elk Island and the peninsula south of it. Drift-deposits seem to cover the outcrop farther south. Owing to the friable nature of the lower beds, an enormous amount of material has been moved and appears as surface deposits. In the vicinity of Elk Island and on Black Island, the boulder-clay is covered to a height, in many instances, of upwards of fifty feet by lacustral sandy deposits, and these are sometimes difficult to distinguish from the Winnipeg sandstones. Mr. Tyrrell records in sections 15 and 16, Tp. 20, R. VII., many large slabs of mottled limestone strewn along the shore, and on the south-west end of Elk Island, a low cliff having twelve feet exposed of the mottled limestone of the lower part of the Trenton. Lower Mottled limestone. Drift-deposits concealing outcrop. Elk Island.

On Black Island the only exposure of beds in place is in the section already quoted in the descriptions of the Winnipeg sandstone, in which four feet of limestone is seen. The presence of this bed capping the sandstones composing the main part of the island is shown by the finding of limestone slabs at various points along the shore, reaching on the south side to past the centre of the island. On the north shore limestone boulders were found only a short distance from the strait separating the two large islands. Limestones on Black Island.

The rocks exposed on Big Island are everywhere thin-bedded, dark earthy-yellow, mottled limestone, weathering lighter in colour. It is immediately above the sandstone which is exposed on the islands to the north, and a small exposure is seen at the extreme northern point. This is a small cliff of ten feet of limestone overlying sandstone of Big Island.

Lower Mottled limestone of Big Island.

which but little can be seen, the face of the lower part of the exposure being covered with débris. Above the limestone cliff is exposed a section of reassorted boulder-clay and gravel, but from the limestone a number of fossils have been collected, of which Dr. Whiteaves determines the following :—

Receptaculites Oweni, Hall.
Orthis tricenaria, Conrad.
Maclurea Manitobensis, Whiteaves.
Fusispira inflata, Meek and Worthen.
Cyrtoceras Manitobense, Whiteaves.

Exposures on south-east shore of Big Island.

These beds are not seen in Gull Harbour to the south-east, but reappear farther south along the eastern shore and form cliffs as far as Hecla P.O. Owing to the slight dip to the south-west, they gradually pass below the lake before the southern end of the island is reached. A nearly continuous cliff extends from near Gull Harbour to the boundary between townships 24 and 25. This is of an average height of twelve feet, showing very nearly the same beds in its entire length. Toward the northern end it is more broken, and has evidently settled down owing to the denudation of the softer beds beneath, by the strong current through the narrows. The height of the base of the limestone, at a distance of only three miles eastward on Black Island, is thirty-five feet above water-level, while on this part of Big Island it is apparently below it.

At Hecla P.O. the exposure is of twelve feet of limestone, reaching to the water's edge, containing an abundance of such fossil forms as *Maclurea Manitobensis*, a large *Hormotoma* and occasionally *Endoceras subannulatum*. The weathered surface is light-gray with yellow markings, but on fresh fracture the colour is darker.

On the western side of the island the exposures are few, if any, but on the two northern points limestone is seen. The extreme north-eastern one has already been described. This exposure continues south-westward for about a mile. Across a bay opening toward Deer Island another exposure is seen. Here the lowest bed of limestone is near lake-level, and about twelve feet of similar limestone is shown, apparently the same beds as at Hecla P.O.

Deer Island.

Above the sandstone exposures on Deer Island, there is a capping of ten feet of limestone overlying a sandstone bed, quite conformable with it, and above the false bedding shown in the sketch. The characters of this stone need not be described in detail, as there is a great similarity

between all these exposures. From this locality a number of fossil forms have been collected of which the following is a list:— Fossils from Deer Island.

Streptelasma robustum, Whiteaves.
Calapœcia Canadensis, Billings.
Glyptocystites, sp. undeterminable.
Diplotrypa Westoni, Ulrich.
Anastrophia hemiplicata, Hall.
Strophomena trilobata, Owen.
Rafinesquina Leda, Billings.
Maclurea Manitobensis, Whiteaves.
Fusispira inflata, Meek & Worthen.
Cyrtoceras Manitobense, Whiteaves.
Harpes, sp. undeterminable.

The limestone exposed on Punk Island is of the same character, and on the north side, it is seen broken up in thin slabs sliding down the face of the exposure.

South side Grindstone Point.

From Little Grindstone Point eastward, blocks are strewn along the face of the sandstone cliff and almost completely hide it, while above, the beds are seen in place, but separated in large masses by vertical cleavage planes. These beds, owing to the yielding nature of those underlying them, easily tip outward, and sliding on one another, cause a vast amount of loose material to be accumulated. In a few of the beds, are seen what appear to be sections of the body-chamber of a large species of *Gomphoceras* cutting them at right angles. These, when broken out of a thin bed, produce circular discs, somewhat resembling a grindstone, and may be the character which is indicated in the name given to the extremity of the point. Grindstones.

Lime-kilns

At Grindstone Point there is only five feet and a half of the Lower Mottled limestone exposed, but farther south-west, more beds are seen above. Near this point, on the south side, the stone has been burnt for lime, and two kilns are still to be seen, though they have not been in operation for a considerable period. The lime burned is said to have been of excellent quality, but the difficulty of shipment by the lake, caused the suspension of operations.

Dip of beds.

The elevations of the lowest bed above the water, between Grindstone Point and Little Grindstone Point, show a uniform dip south-westward, and from a height of forty feet six inches, at the former place, it has fallen to six feet at the latter, showing a dip of thirty-four feet in six miles and a half along the shore, but, if measured with the full dip, it amounts to about eight feet per mile. The beds continue exposed

for about a mile farther, and it is evident that additional exposures are not to be expected, as the plane sinks below the water, while the higher beds seem to have been denuded away, leaving low shores for a long distance southward. The exposures of Grindstone Point are continued westward to the entrance to Washow Bay, and from ten to fifteen feet of strata are exposed.

Bull Head.

The next exposure is on the north side of Washow Bay, and is continuous to Dog Head. The extremity of the point at Bull Head is composed of broken masses of limestone and boulder-clay, forming a small plateau about twenty feet high, extending northward from the higher escarpment of the shore to the south and west. The clay exposed on the eastern side is slightly stratified in the upper part of the section, and the blocks of limestone, which form part of the cliff, are evidently transported a very short distance, from their size and angular form. About half a mile to the south, beds, apparently in place, though probably slidden down somewhat, show nineteen feet of thin-bedded, mottled limestone similar to the Deer Island exposures. Another exposure near the last, shows the limestone in thin layers. The colour is a light-gray, spotted with dark-yellow, but the lower beds are darker and not so mottled with yellow, and seem to contain dark, earthy matter. On the surface they are weathered a rusty-yellow, common to upper and lower beds alike.

Little Bull Head.

Three miles south of Bull Head, the escarpment reaches its maximum height of sixty feet above the water, showing only about nine feet of limestone above an exposure of sandstone beds, previously described (p. 62 F). This broken cliff extends southward to a point about eight miles from Bull Head, and is there seen with the limestone much lower down—about three or four feet above the water. From the nature of the exposure the exact point at which the lowest bed should reach lake-level, is hard to find, but it would be not far from the southern end of the cliff. Broken masses of limestone strew the shore all along the face of the exposure, and indicate the presence of the rock in place in many instances where it is hidden by a dense growth of trees.

Western cliffs at the Narrows.

The Narrows between Bull Head and Dog Head show the near approach of the Cambro-Silurian deposits to the eastern shore. The section made at Dog Head suggests that, underlying the limestone, there is possibly one hundred feet of soft beds. The eastern shore is of Archæan gneiss and granite, forming a fairly straight and high shore. The west side is bold but deeply and irregularly indented, leaving several high points between the bays. One of more prominence than

the rest is called Limestone Cave Point, from the immense fissures in the cliff behind the beach, sometimes forming galleries, as described by H. Y. Hind. This structure is not confined to the above point, but is found all along this shore, and is due to the yielding nature of the underlying rock. Limestone Cave Point.

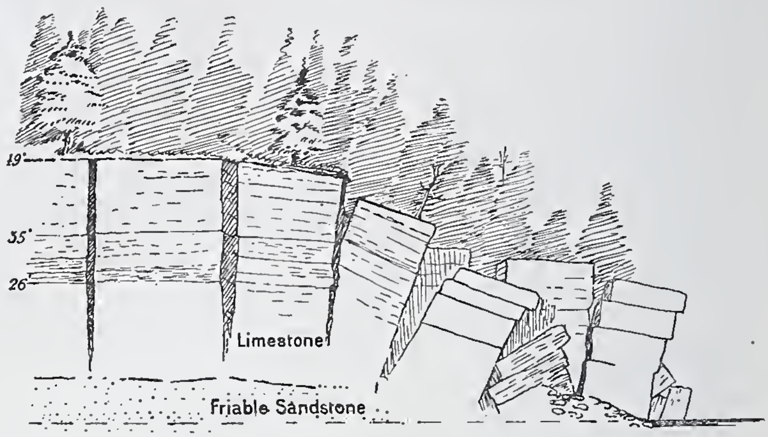
From Dog Head, south for two miles, the limestone is exposed in a broken cliff consisting of pillars and blocks standing back from the beach. They have all been tipped out from their original position in the cliff. The true section can only be measured in crevices back from the outer face. The beds here exposed are summarized in the following descending section :— Section south of Dog Head.

	Feet.	Inches.
Light-yellow limestone, with darker yellow spots, forming about 20 per cent of the mass		0
Dark-yellow beds of similar character to those above, except that the dark spots form 50 per cent of the mass............	5	0

When this rock is exposed, it weathers light-yellow with rusty markings—the same in character as that on Snake Island and the main-land opposite; but, in these large crevices, samples broken off show this light colour to be on the surface only and the original colour to be a dark grayish-yellow in a mass almost bluish. Small grains of pyrites are seen through it, and help to give the exposed surface a rusty appearance. The beds are all very similar but with a darkening in colour in the lower part of the section. The thickness of the beds varies from one to two feet.

The height of the exposures rises toward the south, and at Limestone Cave Point, that of the top bed is forty-eight feet above the lake, or about twenty feet higher than Dog Head. On the shore are seen slabs and pebbles of limestone with a few large blocks that have slidden down. Behind this the slope is irregular, being formed of large blocks, partly concealed by forest, scrub and moss, and separated by wide, deep fissures with steep rocky sides. The vertical jointage is here roughly east-and-west, and north-east and south-west; so that the lines of fractures are roughly parallel to the shores. The beds exposed in these fissures are not shattered and seem to be of a thickness varying from two to six feet, with thinner ones showing at the bottom of the fissure. This broken cliff extends at practically the same level for two miles south, where, in a deep crevice, twenty-three feet of beds were measured. Large blocks have slidden bodily down to the shore, and form an irregular wall; giving an appearance as of a low exposure of limestone, with the top at about fifteen feet above lake, whereas, Slope of surface of limestone. Broken cliffs.

Broken cliffs. concealed by the trees, the solid cliff stands at nearly fifty feet high. A section sketched at this point is here reproduced.



SECTION AT LIMESTONE CAVE POINT.

Boucher Point. The next point south, Boucher Point, is of a similar nature, though not so high; the cliff rising forty-four feet and showing sixteen feet of limestone beds. These are thin-bedded, and split easily into slabs and flags. Other exposures are found across the bay to the south, where the top of the limestone is thirty-one feet eight inches above the lake and ten feet six inches of beds are exposed. At the water's edge a bed of sandstone similar to that at Bull Head is seen.

North shore at Dog Head. The cliff at Dog Head is continued along the north shore to near Snake Island. About twelve feet only is exposed at the point, and the beds are thin or broken, of a yellowish colour, with dark-brownish spots or stains, causing the whole to be evenly mottled. The principal fossils noticed are *Endoceras subannulatum*, *Maclurea Manitobensis*, and *Receptaculites Oweni*. The cliff, though broken, shows occasionally a good section in the crevices back from the face. Nearly two miles westward, the section measured in descending order is as follows :—

	Feet.	Inches.
1. Thinly-laminated beds of spotted limestone	7	0
2. Evenly-grained limestone, with a few dark spots	1	0
3. Soft, spotted limestone, breaking into thin slabs and irregular nodules.	2	8
4. Dark, earthy-limestone, spotted.		2
5. Two beds similar to No. 2.	6	0
	16	10

One mile and a half farther west, No. 4 is a foot and the top of No. 2, four feet seven inches above the water, showing a dip in this direc-

tion of five feet two inches, or three feet four inches in the mile. The cliff there shows an addition of five feet at the top, of beds similar to No. 1. North shore at Dog Head.

One mile west a small exposure shows No. 2 at the water's edge. This increases the dip to four feet seven inches in the mile.

Opposite the southern end of Snake Island, ten feet of limestone similar to No. 1, is seen very much broken into lumpy fragments. Following the same dip with that given by the last two sections, the present one would add four feet to the top beds or, roughly, along this shore, about twenty-five feet of the Lower Mottled limestone is exposed in all.

Low boulder-strewn shores extend westward with no definite exposure of rock in place, to the point west of Moose Creek, where limestone débris indicates the proximity of beds probably below the water level. These may be slightly higher than any seen in the foregoing sections.

The following fossils have been collected from the exposures at Grindstone Point, Bull Head and Dog Head, and represent a similar horizon to that of Big Island and Deer Island, the lowest of the mottled limestones:— List of fossils.

Pasceolus gregarius, Billings.
Halysites catenularia, L., var. *gracilis*, Hall.
Streptelasma robustum, Whiteaves.
Calapœcia Canadensis, Billings.
Glyptocystites, sp. undeterminable.
Lingula Iowensis, Owen
Clitambonites diversa, Shaler.
Strophomena trilobata, Owen.
Plectambonites sericea, Sowerby.
Platystrophia biforata, Schlotheim.
Rhynchotrema capax, Conrad.
Pleurotomaria muralis, D. D. Owen.
Liospira Americana, Billings.
Hormotoma Winnipegensis, Whiteaves.
Maclurea Manitobensis, Whiteaves.
Trochonema umbilicatum, Hall.
" *niota*, Hall.
Fusispira inflata, Meek and Worthen.
Loxonema Winnipegense, Whiteaves.
Endoceras subannulatum, Whitfield.
" *Simpsoni*, Billings.

Poterioceras apertum, Whiteaves.
Oncoceras Whiteavesii, Miller.
Cyrtoceras Manitobense, Whiteaves.
Trochoceras McCharlesii, Whiteaves.
Asaphus maximus, Locke.

Black Bear Island.

On Black Bear Island the beds exposed are of the same horizon with those at Dog Head. The lower sandstone is not seen, and is probably several feet below the lake. Thirty feet of limestone is exposed in one cliff on the eastern side of the island. The upper ten feet is of mottled buff colour, and fewer fossils are found in it than in the lower beds. Toward the centre of the island the upper beds have been removed, and the surface is lowered, sloping toward the south-west. The exposures on the north and west side are of the same beds, which appear to be nearly horizontal.

Fossils collected are determined by Dr. Whiteaves to be of the following species :—

Receptaculites Oweni, Hall.
Halysites catenularia L., var. *gracilis*, Hall.
Fusispira inflata, Meek and Worthen.
Endoceras subannulatum, Whitfield.
Actinoceras Allumettense, Billings.
Illænus Americanus, Billings.

Snake Island.

On Snake Island a cliff of the same limestone is found, exposing about ten feet of beds. The following fossils were collected here :—

Fossils.

Streptelasma robustum, Whiteaves.
Strophomena trilobata, Owen.
Plectambonites sericea, Sowerby.
Orthis subquadrata, Hall.
Platystrophia biforata, Schloth., var. *crassa*, James.
Hormotoma gracilis, Hall.
Maclurea Manitobensis, Whiteaves.
Trochonema umbilicatum, Hall.
Fusispira inflata, Meek and Worthen.
Endoceras subannulatum, Whitfield.
" *Simpsoni*, Billings.

Little Tamarack Island.

Beds very similar and possibly an upward continuation of the ones seen on Black Bear Island, are exposed on Little Tamarack Island about eight miles to the north-west. A low cliff runs along the north shore, composed of eleven feet of thin-bedded limestone of the same mottled character. The fossils procured there belong to the following species :—

Halysites catenularia, Streptelasma robustum, Strophomena trilobata, Vanuxemia sp. indt., *Hormotoma Winnipegensis, Oncoceras Whiteavesii,* and *Illænus Americanus.*

Commissioner Island.

In following these beds northward, the next exposures are found on Commissioner and Berens Islands, though probably at low water some of the bars north of Egg Island may also show them. On Commissioner Island one exposure is known at the north-east point. This shows only a couple of feet of beds of thin, mottled limestone, forming a long bar or point at the east side of Commissioner Harbour. A great similarity between these beds and the lower ones of Dog Head was noticed. Fossils belonging to the following species were collected here :—*Halysites catenularia, Salpingostoma Buellii, Liospira Americana, Hormotoma Winnipegensis, Maclurea Manitobensis, Trochonema umbilicatum, Fusispira inflata, Endoceras subannulatum, Endoceras Simpsoni, Poterioceras nobile, Oncoceras Whiteavesii, Cyrtoceras laticurvatum,* and *Discoceras Canadense.*

Berens Island.

Several exposures on the eastern side of Berens Island are of similar beds to the limestone of Commissioner Island, and are probably just above them in the section. The first locality noted was a low, shelving exposure south of a bay on the east side. The beds there are thin, with fucoidal markings or casts, having a grayish-yellow colour mottled with dark rusty-yellow spots. Northward, the shore trends to the north-east, and at its extreme eastern extension limestone beds are exposed near the water for some distance along the shore, and fragments from these beds have furnished material for a high gravel-beach. The character of the rock is similar to that last noted. Other exposures probably occur on the shoals lying off this point toward Flat Head. On the northern shore low exposures are again seen, and all the beds exposed on the island are practically the same. A few fossils were collected, mostly cephalopods, among which were *Actinoceras Canadense* and *Poterioceras nobile.*

Little Black Island.

Beds similar to those on Little Tamarack Island are exposed on Little Black Island just west of Berens Island. These are above the beds shown on the latter island, and form a cliff fourteen feet high, on the north side. The beds are thin and the face of the cliff is broken or shattered so that it resembles exposures of the upper beds west of Dog Head. The stone is light yellowish-gray, mottled by darker or orange markings. The list of fossils from this locality, is more complete than from any other at which these beds have been examined. It is made up from the determinations by Dr. Whiteaves of specimens

Fossils from Little Black Island.

brought in by Mr. J. B. Tyrrell in 1889, and by Messrs. D. B. Dowling and L. M. Lambe in 1890.

Receptaculites Oweni, Hall.
Halysites catenularia, L., var. *gracilis*, Hall.
Streptelasma robustum, Whiteaves.
Protaræa vetusta, Hall.
" " var. *magna*, Whiteaves.
Arabellites, sp. undeterminable.
Stomatopora Canadensis, Whiteaves.
Orthis subquadrata, Hall.
Platystrophia biforata, Schloth., var. *crassa*, James.
Hormotoma Winnipegensis, Whiteaves.
Solenospira pagoda, Salter var. *occidentalis*, Whiteaves.
Maclurea Manitobensis, Whiteaves.
Trochonema umbilicatum, Hall.
Fusispira inflata, Meek and Worthen.
Loxonema Winnipegense, Whiteaves.
Endoceras subannulatum, Whitfield.
" *Simpsoni*, Billings.
Actinoceras Bigsbyi, Brown.
" *Canadense*, Whiteaves.
Orthoceras Winnipegense, Whiteaves.
Ascoceras costulatum, Whiteaves.
Poterioceras gracile, Whiteaves.
Oncoceras magnum, var. *intermedium*, Whiteaves.
" *Whiteavesii*, Miller.
Cyrtoceras laticurvatum, Whiteaves.
Eurystomites plicatus, Whiteaves.
Discoceras Canadense, Whiteaves.
Trochoceras McCharlesii, Whiteaves.
Aparchites Whiteavesii, Jones.
Asaphus Susæ, Whitfield.
Bumastus Trentonensis, Clarke.

Jack Head Island.

The highest member of the Lower Mottled limestone is that exposed on Jack Head Island lying to the west of Little Tamarack Island. From the eastern point, which is piled high with limestone gravel, numerous small exposures of limestone are seen along the north and western shores. Flat-lying rock is exposed to the east near the water's edge and six feet above this or at the top of the beach-ridge three feet more of the same rock is seen in a small cliff. This is of a hard, mottled limestone of a dark-yellow colour with brownish-yellow

markings, breaking up into lumpy fragments. The beach, which is made up of this rock, consists of irregularly shaped fragments not weathering into discoidal forms. At the northern point there is an

Jack Head Island.

SHATTERED BEDS OF THE LOWER MOTTLED LIMESTONE, JACK HEAD ISLAND.

exposure of fifteen feet of these beds in a vertical cliff, showing the mottled beds at the base with thin-bedded and more evenly coloured ones at the top. These top beds approach in character those classed in the next division as the Cat Head limestone, and are the highest seen on the lake, of the lowest division of the limestones. The fossils collected are referred to the following species by Dr. Whiteaves :—

Fossils from Jack Head Island.

Pasceolus gregarius, Billings.
Halysites catenularia L., var. *gracilis*, Hall.
Columnaria alveolata, Goldfuss.
Streptelasma robustum, Whiteaves.
Strophomena trilobata, Owen.
Rafinesquina lata, White.
Hormotoma Winnipegensis, Whiteaves.
Maclurea Manitobensis, Whiteaves.
Loxonema Winnipegense, Whiteaves.
Endoceras subannulatum, Whitfield.
Oncoceras Whiteavesii, Miller.
Cyrtoceras Manitobense, Whiteaves.
" *laticurvatum*, Whiteaves.

Cat Head limestone.

Characters.

Above the series described as the Lower Mottled limestone, are cream-coloured dolomitic limestones of a general even colour and texture and rather fine-grained, in which are found numerous nodules of chert of varying sizes. The exposures of these beds are seen in greatest thickness along the northern sides of Cat Head and McBeth Point, and are continued westward to Lynx Bay. At the western end or near the entrance to Lynx Bay, the cliff is twenty-five feet from the top bed to water-level. The lower part, seven feet, is a soft, even-grained, yellow dolomitic limestone followed by two feet of the same regular fine-grained stone, but containing large concretions of cherty matter which seem to have had some influence in breaking up the beds. The lines of fracture run outward from the nodules as though from the effect of an expansive force. One kidney-shaped nodule, the largest in the cliff, measured two feet long and eight or ten inches in depth. Above this broken band is three feet of beds of yellow limestone, succeeded by another broken band of three feet, containing also many large nodules. Many of these suggest sponges or corals from their shape at least, but no structure was noted in them. The upper beds are not so cherty, and the top one is covered on the upper surface by rough raised fucoidal markings, though not accompanied by a mottling in colour as in similarly marked beds in the divisions above and below. Towards the east the broken bands vary, and are less distinguishable from the rest of the section, and at Cat Head the lower twenty-seven feet, which seems to be of the same rock, has become evenly spotted with small cherty concretions, and the beds are not so irregularly broken up. The upper part of the section there, shows nearly twenty feet of thick beds of yellow, granular, dolomitic limestone, weathering rough and honey combed. One bed of two feet and a half in thickness, the top of which is forty feet from the water, shows a much more marked fucoidal structure, the softer spots easily weathering away, leaving a very rough face. There is no marked distinction between the contiguous beds, but the rock from the upper part can easily be separated from that of the middle of the section. A correlation of beds in different exposures is difficult. The beds at the top, or at an elevation of twenty-five feet above the lake, two miles west, seem to correspond with those at about twenty-eight feet at Cat Head, showing a dip west of only three or four feet in two miles. This dip must increase westward or these beds would be seen at Clark Point, where much newer ones occur.

Cliff at Lynx Bay.

Chert nodules.

Cat Head

The extreme end of Cat Head is an overhanging cliff with the base exposed to the denuding agency of the waves, and in consequence large

blocks frequently fall. But they seem to be easily broken up and the débris is swept into the bay to the east, forming a high gravel-ridge around the bay and out to a former island, the northern end of which is McBeth Point. Here is a small cliff of the same dolomitic limestone with cherty nodules, showing about twelve feet of beds. They are easily split into thin slabs, and from these at various times a large collection of fossil remains have been collected. The following list, combined with those from Inmost Island, may be taken as forming a fairly complete series from this division.

McBeth Point.

List of fossils from the Cat Head limestone, at McBeth Point :—

List of fossils.

Chondrites cuneatus, Whiteaves.
" *cupressinus*, Whiteaves.
Aulacopella Winnipegensis, Whiteaves.
Trichospongia hystrix, Whiteaves.
Thamnograptus affinis, Whiteaves.
Inocaulis Canadensis, Whiteaves.
Halysites catenularia L., var. *gracilis*, Hall.
Glyptocrinus, sp. undeterminable.
Tæniaster, sp. undeterminable.
Lingula obtusa, Hall.
Strophomena incurvata, Shepard.
Rafinesquina lata, Whiteaves.
Leptæna unicostata, Meek and Worthen.
Orthis tricenaria, Conrad.
Rhynchotrema inequivalvis, Castelneau.
Ctenodonta subnasuta, Ulrich.
Liospira Americana, Billings.
Maclurea Manitobensis, Whiteaves.
Conularia asperata, Billings.
Endoceras subannulatum, Whitfield.
" *Simpsoni*, Billings.
Poterioceras apertum, Whiteaves.
Asaphus gigas, De Kay.
" *maximus*, Locke.

At the south-east side of the entrance to Kinwow Bay, exposures of thin-bedded, fine-grained, dolomitic limestone, are seen on an island lying near the shore. This is Birch or Inmost Island, and the rocks exposed are probably not far below those of Cat Head. These are probably the lowest of this division seen on the lake, and there is probably a gap between them and the upper ones of Jack Head Island. The list of fossils found at this island contains many found at McBeth Point,

Inmost Island.

but also adds many not found elsewhere. It may be here remarked that the state of preservation in which these are found enabled Dr Whiteaves to identify more varieties than was possible in many of th specimens from other exposures.

Fossils.

List of fossils from Inmost Island :—

Chondrites patulus, Whiteaves.
" *gracillimus*, Whiteaves.
Pasceolus gregarius, Billings.
Inocaulis Canadensis, Whiteaves.
Glyptocrinus, sp. undeterminable.
Lingula elongata, Hall.
Strophomena incurvata, Shepard.
Rafinesquina deltoidea, Conrad.
" *alternata*, Emmons.
Leptæna unicostata, Meek and Worthen.
Plectambonites sericea, Sowerby.
Orthis tricenaria, Conrad.
Zygospira recurvirostra, Hall.
Palæopteria parvula, Whiteaves.
Clinopistha antiqua, Whiteaves.
Edmondia vetusta, Whiteaves.
Tetranota bidorsata, Hall.
Pleurotomaria margaritoides, Whiteaves.
Liospira Americana, Billings.
" *angustata*, Ulrich and Scofield.
Maclurea Manitobensis, Whiteaves.
Conularia asperata, Billings.
Oncoceras Whiteavesii, Miller.
Asaphus Susæ, Whitfield.
" *gigas*, De Kay.
Illænus Americanus, Billings.
Bronteus lunatus, Billings.

Outer Sturgeon Island.

Exposures on the north side of Outer Sturgeon Island, north of Saskatchewan Point, are of beds which belong to this division, and are probably of the upper part. On the northern point, a lot of loose limestone blocks are lying on the face of a low exposure of horizontal beds of a hard, semi-crystalline, dolomitic limestone. The lower beds are close grained, somewhat similar to the Cat Head rock and contain many nodules of chert. Above is a semi-crystalline limestone, in some of the beds resembling a sandstone, but generally composed of fragments of shells. Of this there is six feet. Four feet of thinner beds

are on the top and are seen to contain few traces of fossil remains. The broken material from this cliff has been carried partly round the island in both directions, forming high gravel-beaches and bars. That to the south-west, forms a long bar extending nearly half a mile from the island, though part of the material for it, is derived from shelving rock not far below water-level. The fossils collected from this exposure consist of the following species:—*Strophomena incurvata*, *Zygospira recurvirostra*, *Ctenodonta astartæformis*, *Maclurea Manitobensis*, *Conularia asperata*, *Endoceras subannulatum*, *Actinoceras Richardsonii*, and *Cheirurus pleurexanthemus*. Outer Sturgeon Island. Fossils.

Among the St. Martin Islands, no exposures of rock in place were seen on those visited, but loose rock, in the form of high gravel-beaches, having the same character as the beds above described, is a common feature, and it is supposed that the surface of the beds may be just under the lake-level. On Reindeer Island no exposures are seen, but the same loose rock was also noted, though toward the northern end, loose blocks of the Lower Mottled limestone were seen in the boulder-clay. St. Martin and Reindeer Islands.

The Cat Head limestone is exposed at Howell and Robinson points, on the west shore, north of Selkirk Island. The cliffs there are mainly of the Upper Mottled limestone, but the lower bed is of the fine-grained, dolomitic limestone, such as characterizes the Cat Head beds and represent the highest rock of this division seen on the lake. A few feet only is there exposed near the water-line, and it is quite possible that the whole thickness of the division is much less than at Cat Head. North of Saskatchewan River.

Upper Mottled limestone.

The exposures in the valley of the Red River, below Winnipeg, are all of a light-yellowish mottled limestone familiar to the residents as the building stone used in Winnipeg from the quarries at East Selkirk. This is a soft limestone, containing about seventeen per cent of carbonate of magnesia, and seventy-eight to eighty-two per cent of carbonate of lime. The colour is a light cream, mottled with dark-yellow to brown, spots or irregular markings. The stone dresses easily, and also burns to a very good lime. Characters.

On the Red River, exposures are not frequent. Low shelving limestone crosses the river at St. Andrews, but very little is exposed, being covered for the most part by drift.

Lower Fort Garry.

At the Stone Fort, or Lower Fort Garry, an exposure of eight to ten feet of limestone in horizontal beds is seen on the western bank, near the mouth of a small stream entering above the fort. This exposure was noted by Major Long during his expedition to the sources of the St. Peter River in 1823, but no fossils were found in it, and the first discovery of the fossiliferous character seems to have been made by D. D. Owen in 1848. He also noted the dolomitic character of the rock and published two analyses which are given below * :—

Analyses of limestone.

'Compact limestone containing *Leptœna*.

Carbonate of lime	53·7
Carbonate of magnesia	40·5
Insoluble matter	·8
Alumina, oxide of iron and magnesia	4·0
Water, and loss	1·0
	100·0

'Spotted and banded limestone from Red River containing *Coscinopora sulcata*.

Carbonate of lime	78·1
Carbonate of magnesia	17·8
Insoluble matter	1·0
Alumina, oxide of iron and manganese	1·4
Water and loss	1·7
	100·0

Buildings constructed.

This has long been quarried for making lime and for building stone. The walls of the fort and warehouses have been built from stone obtained from this vicinity, and stone was also quarried here for the asylum at Selkirk during the winter of 1883-84. The character of the stone is that of a soft mottled limestone, white and brownish, dressing easily, and similar to that of East Selkirk. Dr. Whiteaves, in vol. III., part III., Palæozoic Fossils, discusses the collections of fossils previously made at this locality, and mentions this as the first locality at which fossils were found in these limestones. The following list is compiled from the above report, and probably includes all the well identified species collected to date.

Fossils.

Receptaculites Oweni, Hall.
Ischadites Iowensis, Owen.
Pasceolus gregarius, Billings.
Halysites catenularia, L., var. *gracilis*, Hall.
Columnaria alveolata, Goldfuss.
Diphyphyllum Stokesi, Edwards and Haime.
Streptelasma robustum, Whiteaves.

* Report by D. D. Owen on Geology of Wisconsin, Iowa and Minnesota, 1852, p. 181.

Fossils from East Selkirk.

Protaræa vetusta, var. *magna*, Whiteaves.
Favosites prolificus, Billings.
Calapœcia Canadensis, Billings.
Pachydictya magnipora, Ulrich.
" *acuta*, Hall.
Phylloporina Trentonensis, Nicholson.
Monticulipora Wetherbyi, Ulrich.
Bythotrypa laxata, Ulrich.
Strophomena incurvata, Shepard.
" *rugosa*, Blainville.
Rafinesquina alternata, Emmons.
" *lata*, Whiteaves.
Leptæna unicostata, Meek and Worthen.
Plectambonites sericea, Sowerby.
Orthis testudinaria, Dalman.
Platystrophia biforata, Schlotheim.
Rhynchotrema inequivalvis, Castelneau.
Byssonychia intermedia, Meek and Worthen.
Modiolopsis angustifrons, Whiteaves.
Conocardium antiquum, D. D. Owen.
Salpingostoma Buellii, Whitfield.
Conradella, sp. uncertain.
Pleurotomaria muralis, D. D. Owen.
Trochonema umbilicatum, Hall.
Eunema strigillatum, Salter.
Fusispira inflata, Meek and Worthen.
" *elongata*, Hall.
Endoceras subannulatum, Whitfield.
" *crassiphonatum*, Whiteaves.
Actinoceras Richardsonii, Stokes.
" *Bigsbyi*, Brown.
" *Allumettense*, Billings.
Tripteroceras semiplanatum, Whiteaves.
Poterioceras nobile, Whiteaves.
Aparchites Whiteavesii, Jones.
Calymene senaria, Owen.
Asaphus Susæ, Whitfield.
Illænus Americanus, Billings.
Bumastus Trentonensis, Clarke.
Cheirurus pleurexanthemus, Green.
Staurocephalus, sp. undeterminable.
Lichas cucullus, Meek and Worthen.
" *cornutus*, Clarke.

East Selkirk.

At East Selkirk there are two exposures, one on the banks of Cooks Creek, to the west of the station, and the other to the south and across the creek. The first has not been used extensively as a quarry, owing to the depth of loose material above the rock. The second is on higher ground, and the rock is, as far as seen, in large loose blocks, though some of it may be in place. The following description of the quarry by the late Prof. J. Hoyes Panton is very graphic and full :*—

Quarry at East Selkirk.

'The exposure is not very extensive as yet, the quarry being opened but a comparatively short time. As you approach this place from the station you perceive that there is a slight elevation, well defined in the vicinity of the outcrop. Looking at the face of the rock you observe that the strata are covered with about four feet of loose drift in the southern part, but full ten in the northern. In this are numerous boulders, a few gneissoid, but most of them the same material as the solid rock, and of a more or less angular nature. The strata on the east side is quite horizontal, but on the west very much tilted. There appears to be a break through the centre of the quarry, indicating a marked upheaval at one time. * * * On the west side there are immense fragments, lying at an angle of 45° with vacant spaces like caves below them. From the raised appearance of this part it seems as if the apparent mound over the quarry has had its origin in this upheaval.

'Fossils appear after the first layer of rock is removed. No part of the quarry as yet seems more prolific than another. The layers of rock are about two feet thick and exposed to a depth of about twelve feet. Neither from personal observation nor from questioning the workmen have I been able to ascertain that certain fossils characterize particular beds. The most casual observer could not fail to observe the fossils on the stones of this place. Remains of cephalopods, corals and the genus receptaculites are seen on every side, the last being exceedingly common. The cephalopods are numerous and large—several five to seven inches in diameter have been observed.

'The rock from this place is largely used in Winnipeg for ornamental stone. Being comparatively soft it dresses readily and takes a good finish, and when burnt produces a very white lime. It is of a grayish-white colour, and effervesces strongly on treatment with cold hydrochloric acid. It presents a peculiar mottled-like appearance which adds much to its beauty as an ornamental stone. This strange mixture of brown and white is difficult to account for. In some cases it appears as if its origin might be due to seaweed re-

*Transaction No. 15, Man. His. and Sc. Soc., Winnipeg, 1884.

mains. Often the coloured portion approaches the colour of yellow ochre, and seems strongly impregnated with iron, while the intervening spaces are more or less coloured. So marked is this mottled condition that the stone from Selkirk district can be distinguished at once from the rock described in a subsequent part of this paper.'

Selkirk quarry.

Mr. Tyrrell's notes contain also a description and as it is later, it shows some features not disclosed before. The following is the extract: 'It [the quarry] is a pit on the west side of a small knol cut down to a depth of about twelve feet. The exposed face runs S. 35° E., and the north end of the exposure consists of horizontall thick-bedded limestone for seven feet, overlain by five feet of till or, boulder-clay, consisting of white clay holding fragments of limestone lying in every direction. The surface of the limestone under this very irregular till, is rough, not being scored or polished. The southern portion of the exposure consists of large irregular masses of limestone, lying in all directions, between which, the spaces are packed with smaller masses and white clay, often with a few pebbles and small boulders of the Archæan rocks. This has evidently been a pre-glacial hill of limestone, and the glacier from the north-east has broken off the upper portion and shoved it down as a tail-deposit behind. Near the station, only a few hundred yards away, it is necessary to dig about thirty feet to the limestone rock.'

Tyrrell's description.

Many fine specimens of fossils have been obtained here by officers of the Geological Survey, and others, notably Mr. A. McCharles and Prof. Panton, have contributed to the collection now in the Geological Survey Museum. The following listis compiled from Dr. Whiteaves's report and contain the names of specimens obtained from all sources :

Collections of fossils.

List of fossils from East Selkirk :—

List of fossils.

Receptaculites Oweni, Hall.
Halysites catenularia, L., var. *gracilis*, Hall.
Tetradium fibratum, Safford.
Columnaria alveolata, Goldfuss.
Streptelasma robustum, Whiteaves.
Favosites prolificus, Billings.
Calapœcia Canadensis, Billings.
Mesotrypa Selkirkensis, Whiteaves.
Strophomena incurvata, Shepherd.
" *trilobata*, Owen.
Rafinesquina alternata, Emmons.
" *lata*, Whiteaves.
Maclurea Manitobensis, Whiteaves.

Fossils from Selkirk.

Endoceras subannulatum, Whitfield.
" *scrassisiphonatum*, Whiteaves.
Actinoceras Richardsonii, Stokes.
" *Bigsbyi*, Bronn.
Orthoceras magnisulcatum, Billings.
" *Selkirkense*, Whiteaves.
Tripteroceras Lambii, Whiteaves.
Poterioceras nobile, Whiteaves.
Oncoceras magnum, Whiteaves.
Trochoceras McCharlesii, Whiteaves.
Asaphus Susæ, Whitfield.
Illænus Americanus, Billings.
Bumastus Trentonensis, Clarke.
Pterygometopus callicephalus, Hall.
Cheirurus pleurexanthemus, Green.
Staurocephalus, sp. undeterminable.

The presence of corbonate of magnesia in this stone is shown in the subjoined analysis and is practically the same as that found by D. D. Owen in the spotted and banded limestone at Lower Fort Garry.

Analysis of building stone from quarry at East Selkirk.*

Analysis of building stone

'Specific gravity, (temp. 60° F.) 2·7025. Weight of one cubic foot, (calculated from specific gravity) 168·9 pounds.

'Absorbing power—(the numbers represent the absorption obtained by the aid of the air-pump).

'Water absorbed, per cent, 3·471. Weight of water absorbed by one cubic foot of the rock, 5·86 lbs.

'After drying at 100° C., its composition was found, by Mr. F. D. Adams, to be as follows:—

Carbonate of lime	82·612
Carbonate of magnesia	16·922
Ferric oxide and alumina	0·302
Silica (dissolved)	0 032
Insoluble matter	0·913
	100·781

Another exposure of these beds is described by Mr. A. McCharles as being on Sec. 6, Tp. 13, R. VI. east, about five miles to the south-east of Selkirk Station. 'There is a natural exposure of similar strata in two small hopper-shaped holes close to each other at the junction of a low marsh with one of the gravel ridges that are so common in that

* Report of Progress for 1882-84, p. 1. part M.M.

locality. The stone is thinner-bedded, and therefore broken into smaller blocks than at the Selkirk quarries, though otherwise the same in every respect. But this outcrop is seldom worked, as it is usually under water in ordinary seasons.' * Exposures elsewhere.

It is impossible to judge the exact position of these with relation to the Selkirk beds, but they may be lower. The beds at Lower Fort Garry are of about the same horizon as those at Selkirk.

On the lake northwards, similar beds were seen at the mission on Fisher River, but the fossil remains found were of an obscure nature and only one, *Actinoceras Bigsbyi* can be definitely determined. This has also been found at Lower Fort Garry and East Selkirk and ranges down through the lower divisions. The exposure there is in the bed of the river at the first rapids. It shows two feet of a soft fragmental rock containing small crystals of calcite and white streaks from the remains of shells, &c. Mouth of Fisher River.

Yellow spots give it the same mottled appearance, and in hardness it closely resembles the Selkirk stone. The rock contains many softer pulverulent portions. To some extent the same is the case with the Selkirk stone. A few fossils not identified were a valve of a large brachiopod and a coiled cephalopod.

One mile south from the mission, a ridge elevated four or five feet above the general surface, is covered with slabs and loose blocks of limestone. They appear to be derived from beds below, but may have been moved a short distance. The absence of other varieties of limestone seems to point to their being near the parent beds. The slabs are of a dark-yellow granular limestone with many cavities partly filled with a light, ochreous powder. A few fossil brachipods and a branching coral something like *Diphyphyllum Stokesi* are found in this rock, which, if in place, must be at least eight feet above the whitish limestone in Fisher River.

In the northern part of the lake, there are beds which are considered to be of the same horizon as those of Selkirk, but their characters are varied. The mottled parts are rather darker in colour and much harder, and the thickness of the division is much reduced. Above these and apparently just below the Stony Mountain shales, are much darker beds with several clayey layers. North-west shores of lake.

Other exposures are seen at Dancing Point, where a low cliff shows four feet and a half above the water, extending 100 yards along the Dancing Poin

* Transaction No. 27. Hist. & Sc. Soc. of Man., Winnipeg, 1887.

Dancing Point

shore. The beds are about horizontal, and the surface forms a flat table, which has been somewhat smoothed by glacial action and shows a few striæ. This rock is a dark, semi-crystalline, dolomitic limestone rather harder than that at Selkirk. A few badly preserved fossils were obtained here, including *Streptelasma robustum* and *Orthis proavita*.

Carscallen Point.

Opposite the St. Martin Islands, at Carscallen Point, are several exposures of beds which possibly occur just above the Dancing Point rock. They are of a soft impure limestone, dull yellowish-gray, and semi-crystalline, in beds from two to three feet thick, but splitting up into thin flags. The thickness exposed in the bay to the north of the point is eleven feet ten inches. Under this is a fine-grained yellow limestone, the upper part evidently fragmental—a few inches of a thin bed at the top being a conglomerate with rounded pebbles of the same material as the matrix, though not of as dark a colour. Of these fine-grained beds there is about two feet three inches shown above the water. The stone breaks readily with a smooth fracture and on a weathered surface the conglomeritic nature of the upper part is strongly shown.

This exposure is on a slight anticline which brings up the yellow beds at the centre. On the point the beds exposed are practically the same as those in the bay noted above. They dip slightly to the west, and at the water-line another bed of the fine-grained limestone is exposed, in which are seen some obscure fossils. In the upper part the conglomeritic band does not show in as marked a manner as at the last exposure. The upper part of the section consists of the dark-yellow semi-crystalline rock noted above. Of this there is a thickness of ten feet in which a few fossils were found. The following comprising those that have been identified:—*Strophomena trilobata*, *Rhynchotrema capax* and *Orthoceras anellus*.

Clark Point.

This band is again exposed at Clark Point (Limestone Point of Hind) the north-west corner of Sturgeon Bay, in a cliff showing a vertical section of fourteen feet. In the upper part, the beds are a yellowish-gray limestone, with several thin bands of soft clay parting the beds. The stone is soft and easily broken up, showing a good deal of clayey impurity. The section shown is as follows, in descending order:—

	Feet.	Inches.
Greenish-gray, soft, impure limestone	2	6
Seam of light clay	0	1
Beds in some places very rotten and easily broken, argillaceous	2	3
Clayey bed	0	3
Harder limestone, gray-green, earthy	2	10
Shaly band and dark impure limestone	2	6
Blue limestone, weathering gray		4
Bluish-gray limestone, harder than rest of section	4	0
	14	9

Fossils found in these beds :—*Inocaulis Canadensis, Strophomena trilobata, Leptæna unicostata, Maclurea Manitobensis, Trochonema umbilicatum, Actinoceras Richardsonii, A. Python, Orthoceras Whiteavesii* and *Trochoceras McCharlesii.* West side Sturgeon Bay.

Similar beds are exposed at the mouth of the Little Saskatchewan River. That is, the lower beds of the above section are probably found there, but the remaining ones, extending to the foot of the rapids seem to be denuded, leaving perhaps a higher bed exposed there. These seem to be passage beds to the shales of the Stony Mountain formation, and similar ones may perhaps be found along the Red River near Winnipeg. The rocks at Bishops' quarry near St. Andrews are described as being fine-grained, dark-yellow, and are doubtless the lower part of the transition beds, though they suggest very much the rock at the lower part of the section at Carscallen Point.

Northern section.

In the northern part of the lake, the section of the Upper Mottled limestone seen, is of no great thickness, comprising those beds exposed on Selkirk Island and on the points on the mainland northward. Between this and the Silurian at the rapids on the Saskatchewan River, there are no exposures, and the soft beds of the Stony Mountain formation have been denuded, while the possible thickness of this formation is reduced to a very thin section. The mottled beds of Selkirk Island are exposed in several points around the island. The lowest are at the north end. There the exposure shows ten feet of a hard dolomitic limestone, mottled with dark olive-brown spots, the matrix generally a dark yellow. This is in thin or shattered beds which seem to lie about horizontal. The lower beds are richer in fossil remains, but do not hold a great variety. Those identified by Dr. Whiteaves are the following :—*Streptelasma robustum, Orthis proavita, Rhynchotrema capax, Orthodesma affine, Maclurea Manitobensis*, and *Actinoceras Richardsonii.*

Selkirk Island

Two miles south, on the western side of the island, limestone is again seen in cliffs showing twelve feet of beds. These are quite thick, but are easily broken up into irregular fragments, in fact the face of the cliff is shattered. Very few fossils seem to be preserved in this rock, which is a hard dolomitic limestone of a yellow colour, with darker stains running through it. The darker parts are much harder than the light, and the surfaces of beds or fractures are in consequence lumpy. These beds are again seen in cliffs a mile and a half farther south. Near the south end of the island flat beds occur near the water's edge. They are somewhat harder and finer-grained than the last, and of a dark orange colour—where polished they are dark

reddish yellow. The top surface is planed by glacial action, and a few fine striæ are observed bearing south. On the eastern side of the southern end of the island broken cliffs continue to abreast of Horseshoe Island, on which is also an exposure. These show about twelve feet of a hard dolomitic limestone similar to the upper part of the exposure at the north end of the island. The fossils are badly preserved, and no new species are added to those enumerated above.

Robinson Point.

On the mainland, these beds are seen in several exposures, running from a point west of the north end of Selkirk Island (Robinson Point) to Howell Point, near the Eagle Islands. At Robinson Point nearly twenty feet is shown. The upper beds are thick, measuring 4 feet 3 inches and 5 feet 6 inches, then in the lower part—ten feet—what appear to have been thick beds are very much broken up into thinner layers. Passing northward the beds rise slightly, bringing up lower beds which are of a finer grain, and as before noted, approach the characters seen in the Cat Head rocks and resemble very much those on Outer Sturgeon Island.

Fossils.

A large collection of fossils was made at Robinson Point, and those identified by Dr. Whiteaves were of the following species:—*Pasceolus gregarius*, *Halysites catenularia* var. *gracilis*, *Streplelasma robustum*, *Dinobolus parvus*, *Strophomena trilobata*, *Leptæna unicostata*, *Orthis subquadrata*, *O. proavita*, *Rhynchotrema capax*, *Tetranota bidorsata*, *Pleurotomaria Stokesiana*, *Maclurea Manitobensis*, *Subulites*, *Actinoceras Richardsonii*, and *Asaphus gigas*.

Sturgeon-gill River.

A few miles north at a point to the south of the mouth of Sturgeon-gill River, Mr. Tyrrell measured several sections. The beds are similar to those of Robinson Point, with the addition below of beds resembling the cherty beds of Cat Head. The first section is in the bay at the mouth of the above stream, and shows an exposure as follows:—

Section.

'Cliff showing thirty-two feet of cream-coloured limestone similar to that farther south, but more even in grain and without fucoid impressions on the weathered surface. In contains a considerable number of impressions of salt crystals, and also some fossils, though they are very difficult to get out. They are chiefly *Favosites*, *Zaphrentis* and large beaded *Orthoceratites*. At the edge of the water is a bed of very hard, compact and moderately thin-bedded limestone, very much broken and breaking with a porcellanous fracture.'

At the outer end of the same point the cliffs are thirty-five feet in height, consisting of the following descending section as measured by Mr. Tyrrell :— Near Sturgeon-gill River.

	Feet.	Inches.
Thick and evenly bedded, even-grained, yellow dolomitic limestone	28	0
Thin band holding considerable quantities of pyrite		
Thin bedded limestone, generally hard, but with many pits or impressions of salt crystals	4	0
Yellow, porous, thick-bedded limestone	2	0
Moderately thin-bedded, blue clayey-limestone	1	0
	35	0

'On the slabs on the beach are impressions of the same fossils as before. Some pieces of rock were found holding nodules of flint possibly from the pyrite band.'

At Howell Point the cliff is not so high, but shows a bed three feet below those given in the above section. Mr. Tyrrell's section is as follows :— Howell Point.

	Feet.	Inches.
Horizontal, cream-coloured, dolomitic limestone, containing *Orthoceras Richardsonii* and a large *Gyroceras*	10	0
Apparently unconformably underlying this is a very porous or vesicular yellow limestone, with some impressions of salt crystals, and containing in its lower portion great numbers of concretions of flint	5	0
Conformably below this is a blue, compact limestone and a light-gray, hard, evenly-bedded limestone with porcellanous fracture	1	4
Covered by débris	3	0
At the edge of the water is hard blue, argillaceous limestone in places slightly brecciated or a conglomerate. In places it is evenly bedded and in others it is in little clayey domes.	1	0
	20	4

In the bottom of the bay to the north the cliffs are also seen and the following notes are extracted regarding them :—

'The rocks are dipping slightly to the south, and coming southward the following decending section is seen :—

Evenly-bedded, cream-coloured limestone, such as we have seen before	4	0
Yellow vesicular limestone containing a large number of impressions of salt crystals, nodules of flint and a few fossils .	4	0
Blue, often shaly and probably arenaceous limestone, which in places becomes a moderately fine conglomerate. This conglomerate is occasionally quite sandy in little pockets and strips. It varies somewhat in thickness, the surface of the hard limestone below it, being quite irregular	1	6

Howell Point.

Light-yellow, hard porcellanous limestone, almost horizontal, but lightly undulating. Its surface is very much cut by cracks running in every direction. Generally it breaks in thin resonant slabs. It is divided by several bands of blue shaly limestone that are probably slightly arenaceous and often contain little bands of conglomerate from the water up. It contains a few nodules of flint....................	10	6
	20	0

These sections show that probably the entire thickness of the Upper Mottled limestones as shown at the exposures of Selkirk Island and Howell Point, is much thinner than farther south. The Cat Head beds are also seen at the base of these northern cliffs.

Lake St. Martin.

In the topographical descriptions of the different divisions no references are made to the Trenton rocks of Lake St. Martin basin. The only fossils found so far are indefinite, as they include impressions of parts of a brachiopod having sculpture resembling *Strophomena alternata* and a cup-shaped coral, undetermined. These are not sufficiently typical of any of the subdivisions of the Cambro-Silurian to admit of their being placed in any definite horizon.

Stony Mountain formation.

Stony Mountain formation.

The only natural exposures of rocks referable to this formation are confined to Stony Mountain and Little Stony Mountain. At the former place, the upper limestones are exposed on the face of the hill, but in digging a well for the provincial penitentiary, situated on the south-west spur of the ridge, a section of one hundred and ten feet was exposed. The record published by Prof. Panton for this section is as follows :—*

Penitentiary well-section.

	Feet.
Solid, hard stone, like that at the quarries............................	20
Thin layers of the same..	4
Solid rock	2
Thin and broken..	6
Yellowish rock, quite ochreous......................................	8
Reddish layer full of fossil shells....................................	10
A mixture of yellow and red containing some flinty material...........	60

A general description and section of the surface outcrops on the western face of the escarpment is given from Mr. Tyrrell's notes for 1897, and is as follows :—

'Stony Mountain rises as a conspicuous rounded hill, sixty feet above the surrounding grassy plain. On its summit is a gravel plain

*Transaction No. 15, Man. Hist. and Sc. Soc., Winnipeg, 1884.

J. B. Tyrrell, Photo.

LIMESTONE CLIFFS NORTH OF HOWELL POINT, LAKE WINNIPEG.

or ridge, beneath which is a thick band of bedded limestone, below this again is light-gray, yellowish and red, argillaceous limestone of Hudson River age [Stony Mountain formation]. Toward the west, between it and the ridge extending south from Stonewall, is a wide drift-filled valley. The face of the cliff is very steep even below the drift, as Mr. Gunn sank a well forty-two feet close to the foot of the cliff without coming to rock. The top surface of the hill, in plan, resembles a great horse-shoe opening to the south, and its summit is everywhere composed of flat-lying limestone which is usually yellow and more or less riddled with cavities. It is usually yellowish in colour, but occasionally has reddish streaks, and on the eastern arm of the shoe it seems to be rather thinner bedded than on the western. In places the rock seems to be streaked with many impressions of plants. Stony Mountain.

'The following is a descending section seen in Mr. Gunn's quarry :—

Section in quarry.

	Feet.	Inches.
Bed of gravel	2	6
In some places this is replaced by a thin coating of boulder-clay.		
A yellowish-gray limestone in which are some bands mottled with red	6	6
It has a few cavities and fossil *Beatricias* are fairly abundant. On the exposed surface it is lying in horizontal beds two to four inches in thickness and these beds have not been used for dimension stone.		
A similar grayish-yellow limestone, some bands being mottled with reddish or brown spots	9	5
Limestone, for the most part in porous, horizontal layers. There are one or two reddish bands which are usually more compact and clayey than the rest, though they are a good, durable stone. Some of these beds are cut for dimension stone.		
Thick-bedded, yellowish-gray argillaceous limestone, mottled with red blotches. It is softer than the higher limestone, but is said to harden as it dries. The well was bored eighty-six feet from the top of this band	3	6
Soft, greenish-gray, very argillaceous limestone with some bands that are very red and mottled	3	4
Covered, but probably composed of soft, yellowish-green, shaly beds, for little patches of yellowish fossiliferous beds can be seen in places	5	5
Red, highly fossiliferous shale, with many thin bands of limestone from one to three inches in thickness	10	8
	38	10

'This section is carried down to the spur of the railway track, said to be sixteen feet above the level of the main track out on the prairie beyond.

'The well referred to above was drilled in the quarry, beginning 15 feet 11 inches below the top of the rock in the above section, and was Well in quarry.

Well-sections. carried down eighty-six feet through soft, chiefly reddish limestone, probably clayey, to a band of hard limestone from which a supply of water was obtained.'

The characters of the various beds change somewhat, as will be seen by a comparison of the two sections. The surface beds at the penitentiary, appear to be slightly higher than those of the quarry, while the limestone bed yielding water at the bottom of the two wells is possibly the same. The upward extension of the section to the exposed Silurian rocks of Stonewall is found only in well-sections at that place, and shows that probably the top of the Stony Mountain formation is the bed exposed on the surface of the hill at the quarry. The succeeding bed, a white limestone very similar to the Stonewall rock, contains a large per cent of silica or sand, and is probably the basal bed of the upper series The character of the lime burned from the rock at the two localities is a convenient local distinction. Stonewall lime is very white, while that made at Stony Mountain is much darker and yellowish. The Silurian rocks above the Stony Mountain section are given in the following combined section from wells in Stonewall examined by Mr. Tyrrell in 1897 :

Silurian rocks

Section between Stonewall and Stony Mountain.

Rutherford's well—

	Feet.	Inches.
Thick and moderately regularly bedded white limestone, similar to the beds in the quarry	8	6
Irregularly bedded, brittle, white limestone, broken by numerous fractures and with many small cavities	8	3
Red or pinkish argillaceous limestone, rather irregularly bedded, though some of the beds are quite thick	14	0

Lusted well—

	Feet.	Inches.
Fine-grained, white, rather clayey, brittle limestone, slightly greenish toward the top, usually rather thick-bedded, but in places thinly or irregularly bedded, silicious	8	6
Gray, thick-bedded, rough breaking, limestone in which are many holes left by the dissolving away of salt or the decay of fossils. This is apparently the same bed that is quarried at Stony Mountain	6	0
	45	3

Little Stony Mountain.

Little Stony Mountain was visited by Mr. Tyrrell, and his description and section of it is given below :—

'This is a low ridge running north-and-south and wooded with small poplar on its western side, making it seem higher than it is. There are two quarries, one owned by the city of Winnipeg, and the other by Mr. Egan. In the former some excellent dimension stone and stone for foundations is obtained, and a large amount is also crushed for

street paving. It is opened for one hundred yards in length, and about half as wide, on the eastern side of the ridge. In Mr. Egan's quarry, a short distance farther south, the thick beds appear to have an addition

Diagram of sections.

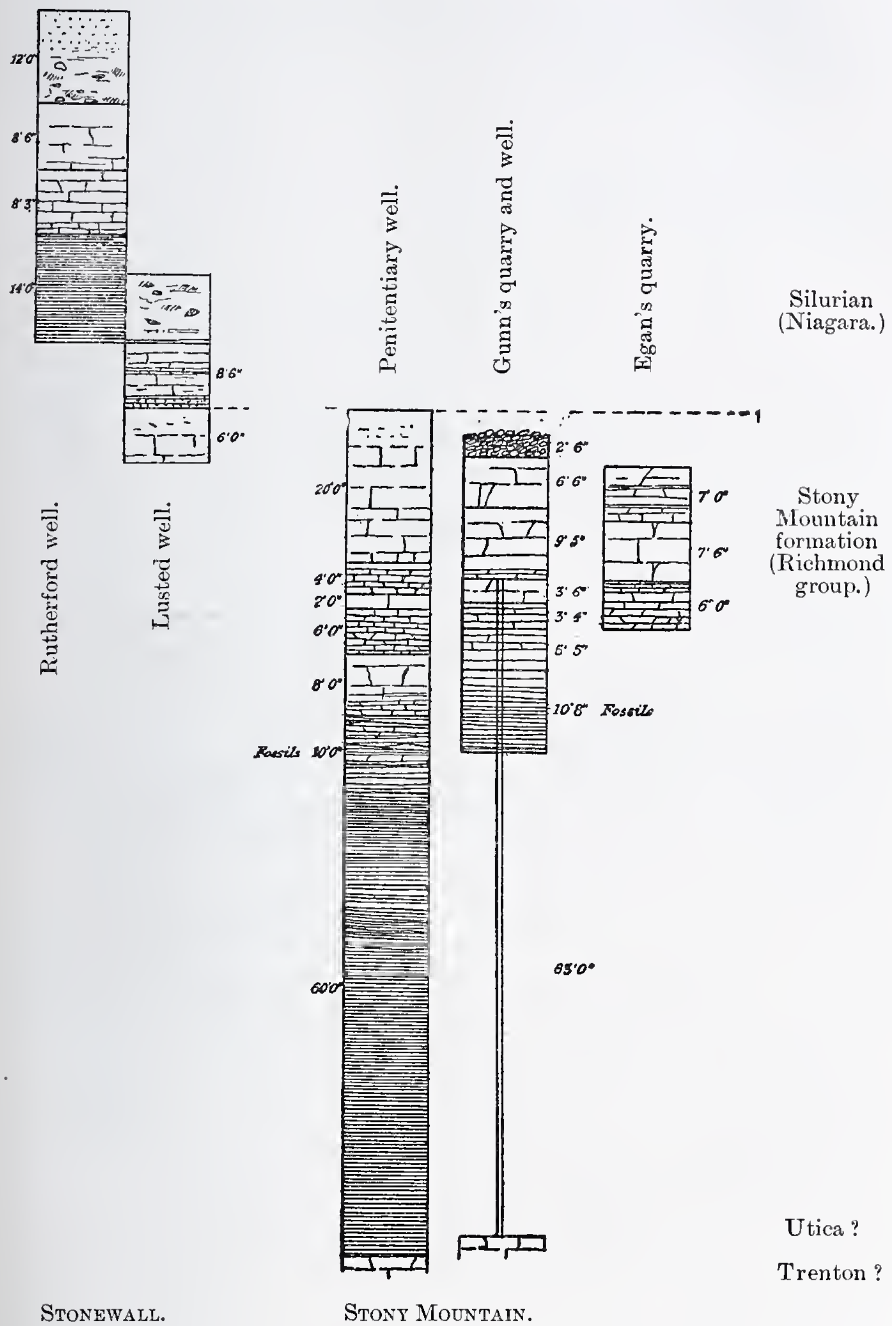


DIAGRAM SHOWING COMPARATIVE SECTIONS AT STONEWALL, STONY MOUNTAIN AND LITTLE STONY MOUNTAIN.

Little Stony Mountain.

of one or two feet. The section observed is as follows in descending order :—

Egan's quarry

Unevenly bedded more or less argillaceous limestone, the beds often having shaly partings or being very much broken. At the top is a bed nearly two feet thick, pretty uniform in texture and granular..................................	7	0.
Moderately thick-bedded, hard, whitish limestone, many of the beds riddled with cavities. These are the beds worked in the quarries and the only fossil found so far is a large *Beatricia*..	7	6
Light greenish-gray argillaceous limestone, thick or thin-bedded, varying to shaly. It shows a number of impressions of fossils	6	0
	20	6

Winnipeg.

Under the city of Winnipeg, red impure limestones and shales are reached in boring for wells. Near the eastern part of the city the surface of the underlying rock slopes very abruptly to the east, showing that probably these red beds represent the surface of a bed of limestone which is broken down near the river, forming a steep step. The average depth given for the surface of the rock is about sixty feet under most of the city, but at Point Douglas it is increased to one hundred and twelve feet.* The western bank of the Red River at this locality may be taken to be the eastern limit of the Stony Mountain formation.

Rosenfeld.

In the southern part of the province no exposures are found, but in the Rosenfeld well-section* there seems to be a great thickness, amounting to one hundred and ninety feet of shaly beds and limestones (Nos. 12-13), situated just above three hundred and five feet of limestone (No. 14) representing the Trenton of Lake Winnipeg.

Distribution northward.

Toward the north, this formation evidently thins out very much, and sections of it are not seen on either the Little Saskatchewan River or between the Silurian at the Grand Rapids of the Saskatchewan and the Trenton rocks of Selkirk Island. If there were a series of shales and limestones amounting to a few feet only, exposures might not be expected, and there seems little probability that the bulk of the section as represented in the south, occurs in this locality. The dip of the beds is light and to the south-west and it is probable that the Silurian here overlaps the thin edge of the Stony Mountain formation, the eastern edge of which, might be described as following a line from near Winnipeg north-westerly, skirting the west side of Lake St. Martin,

* *See* Footsteps of time in the Red River Valley by A. McCharles. Transaction No. 27, Man. Hist. and Sc. Soc., Winnipeg, 1887.

* On certain borings in Manitoba and the North-west Territories by Dr. G. M. Dawson, Trans. Royal Soc. of Canada, vol. IV., part IV., 1886.

and thence north probably altogether beneath the Silurian except at the localities above described. Some doubtful beds near the mouth of the War-path River and at Shiel Point have already been referred to, but the absence of fossils prevents any definite correlation being made, although they resemble some of the beds at Stony Mountain and are above the Trenton rocks of Carscallen Point to the south and Dancing Point to the north. Shiel Point.

The fossils so far recorded from these beds, have been compiled by Dr. J. F. Whiteaves, and published in vol. III., part II. Palæozoic Fossils (Geological Survey of Canada) and are incorporated in the list of fossils given in the present report. Fossils.

Superficial Deposits.

Boulder-clay or Till.

The mantle of boulder-clay which in southern Manitoba seems to be of a maximum thickness of nearly one hundred feet, is found to be much lighter in the northward extension of the basin, and toward the eastern side, on the high land from Grindstone Point to Dog Head, a slight covering only, is found. Very few sections are seen, and the presence of boulder-clay is inferred in many places from the contour of the surface. The high ridge forming Long Point, is connected to the ridge separating Cedar Lake from Lake Winnipegosis, which is believed to be a great moraine. Sections are found on the south side of Long Point, showing light-coloured clay with few boulders. One or two large boulders are exposed, however, in the bank, embedded in a fine clay containing few pebbles. North of the point, the surface is found to be ridged in the direction of the glacial movement and the general description of the shore from the Saskatchewan River to Long Point suggests the possibility of these being of the nature of drumlins. A section of one of these, near the Saskatchewan River, shows a light-coloured clay with numerous pebbles, and many large boulders of light-coloured limestone, all well striated. South of the Long Point ridge, a mantle of reassorted boulder-clay is found covering any boulder-clay which may exist there. This mantle appears, however, to have been of slight thickness, as ridges similar in outline to those on the north side of Long Point are found in many places. Boulder-clay Long Point.

Glacial Striæ.

Glacial striæ.

List of striæ observed on islands and west shore of Lake Winnipeg :—

Selkirk Island	S. 1° E.
Howell Point	S. 2° E.
Dancing Point	S. 35° E.
Shiel Point	S. 35° E.
Berens Island	S. 40° W.
Jack Head Island	S. 25° W.
Snake Island	S. 25° W.
Black Bear Island	S. 47° W.
Little Grindstone Point	S. 42° W.

In the above list the first four records are from localities on the western side of the lake, and were doubtless made by the southward-moving Keewatin glacier. The remainder are from localities nearer the eastern shore, and were made by the later glacier that advanced from the north-east.

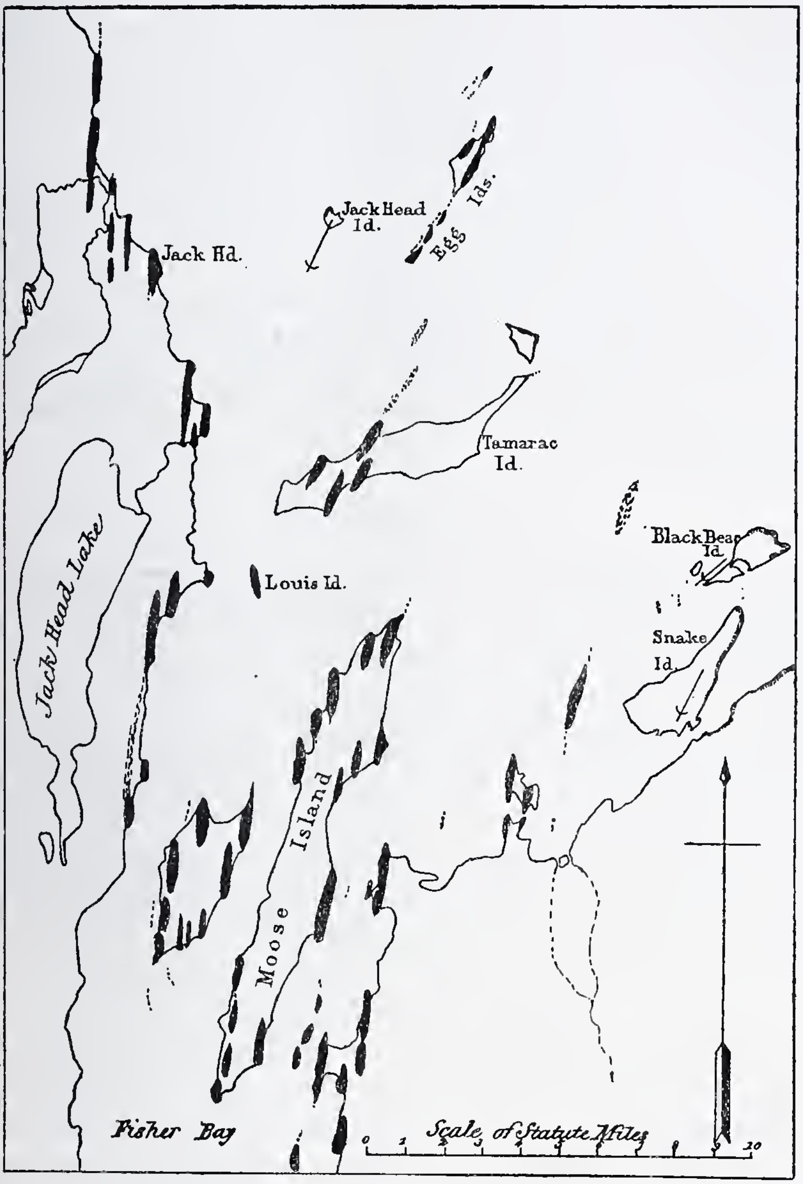
Drumlins.

Drumlins.

Although the surfaces of the ridges of this character observed appear to have been slightly modified by a thin covering of stratified material, their basal composition and form have a direct connection with the direction of the glacial movement. Those noticed to the south of Long Point are briefly the following :—The group of ridges found on Reindeer Island, particularly on the south shore, and the accompanying ones forming the greater part of the St. Martin Islands; the group in the centre of Sturgeon Bay forming the Sturgeon Islands, and also the two large islands called the Inner Sturgeon Islands. To this we may add several lying south of Berens Island as well as those illustrated in the accompanying sketch. To the east and north from Cat Head a string of islands running about S. 35° W. from the eastern side of Berens Island is paralleled by a ridge on the western side of Commissioner Island. These seem to lie parallel to the glacial striæ, which were observed on the north side of Berens Island to run S. 40° W. Several of these might be overridden lateral moraines of the earlier glacier, though their origin can not be clearly made out. They are therefore enumerated in the drumlin series.

The next group, at the mouth of Fisher Bay and on islands northward, no doubt contain examples of moraines, but a reference to the map and sketch appended, show that they are intimately related as a whole. The striæ found at Snake Island and Jack Head Island bear S. 25° W., and appear to be nearly parallel to the ridges in the vicinity.

Those on Black Bear Island turn more to the west, following the general direction of the shore at that point. If the basin afforded more examples of striæ to the south-west of the points above noted, it Drumlins.



SKETCH OF PART OF LAKE WINNIPEG, TO SHOW INFLUENCE OF DRUMLIN RIDGES ON CONTOUR OF BEACH-LINE AND THEIR RELATION TO GENERAL DIRECTION OF GLACIATION.

might reasonably be expected that they would show a deflection toward the south and into Fisher Bay, following also the west shore. This, it will be noted, is the course followed by the ridges, and the

relation between these and the glacial striæ is thus apparently maintained.

Fisher Bay to Jack Head.

In the area shown on the sketch-map, the basin is very shallow and the land is not much elevated above the lake; indeed a rise of fifteen feet in the lake-level would submerge nearly all the islands west of Snake Island and enlarge the width of Fisher Bay. Slight ridges are thus easily distinguished on such a low plane, and are found to have an important influence in shaping the contour of the shore-line. This is noted especially on Tamarack Island and on the shore of the eastern entrance to Fisher Bay. Looking from Snake Island north-westward, the only trees seen on Tamarack Island are those on the ridges, the tamarack swamp forming the remainder of the island being below the line of sight. Moose Island, properly speaking, is one long ridge, but the lesser ones forming the points are noticeable. Eastward, owing to the low country, the ridges marked above, appear from a distance as a group of islands.

Reassorted Boulder-clay.

Reassorted boulder-clay.

Exposures of this deposit are not numerous, those noted being mainly on the west shore. The ridge described as occurring near Jack Head River is composed partly of reassorted material, but the section of it on the lake-shore shows only about three feet. The stratification is indistinct, but the material was evidently deposited in water. The clay is of the boulder-clay type, and is plentifully supplied with both large and small boulders of gneiss and limestone.

On Fisher River, the deposit is of a more pronounced stratified type with fewer boulders; and farther south, near Gimli, cut-banks on the shore show a decidedly stratified clay.

Stratified Sands and Gravels.

Stratified sands and gravels.

On the south side of the eastern end of Long Point, a low exposure of coarse stratified sand is found. This is a deposit of later age than the clays forming the point, and undoubtedly overlies them. The group of islands lying to the eastward in the centre of the lake, George and Sandy islands, are composed of stratified gravels and sands forming small plateaus. The middle one of the Sandy Islands is the largest, and shows the best section of the gravel terrace on its southern side. The highest point of this appears to be about fifty-five feet above the lake.

George Island is the next in size, and the section is there very similar to that of the first. In both, the highest part of the deposit is on the south-west side, and the surface of the terrace slopes from this point slightly toward the north-east. The sections exposed show clearly the stratified nature of the terrace, but those on the face of the higher accumulation are not so definite. It seems probable that the higher parts represent the remains of esker deposits flanked by the reassorted material in the form of small plateaus. This is suggested in part, by the fact that these islands are arranged in a broken line running from near Poplar Point on the east side out in a north-westerly direction toward the end of Long Point. Stratified sands and gravels.

The higher portions of the smaller islands are liberally sprinkled by large Archæan boulders, evidently carried there by floating ice during a higher stage of the lake, shortly after this deposition of material, and while the plateaus were being formed.

Stratified sands very similar in general structure are found near Elk Island on the south shore. Boulders were there noted sliding down the face of the banks, as though falling from the surface. In this connection it may be mentioned that Bird Hill, east of the Red River, north-east of St. Boniface, presents somewhat similar deposits.

Lake beaches.

The formation of a beach commences primarily by the accumulation of the heavier débris left by the denudation of the shore. This may form a boulder-ridge, grading down to a gravel- or sand-bar, as the result of the denudation of boulder-clay, or bars of a more uniform composition if derived from exposed cliffs of stratified rocks. Later on, however, the transporting action of the waves, effects a change in their composition, boulder pavements being covered by gravel of a totally different origin, or by sand from an adjacent point. On Lake Winnipeg the transported beaches particularly noticeable are those of limestone gravel from the cliffs of Trenton limestone exposed on the lake. Beaches.

Boulder beaches or pavements.—These may be classed under two heads, corresponding with the origin of those found on the lake. On the western side, in the shallower parts, the ridges described as being of the nature of drumlins in contour, are found to have remarkably rough bouldery shores, especially at the northerly and southerly extremities, often forming long bars extending out in the lake. The boulders seem to be derived from the boulder-clay forming the points of the ridges. They are thus left in place while the finer material is Boulder beaches from boulder-clay.

Boulder beaches.

assorted and spread over the bottom of the lake. This action is particularly noticeable on the western shore. The boulders derived from boulder-clay forming the string of islands running south from the east side of Berens Island form pavements and bars that are good examples. Plunkett Island, on which the lighthouse is placed, is surrounded by so rough a wall of boulders that a landing place for small boats can hardly be found, except at an artificial slip in front of the keeper's house.

From terraces.

Another system of boulder ridges is found on the islands in the large open part of the lake—Sandy and George islands. These being formed of easily eroded material have had their sands and gravels distributed around their margins, but falling from the surface in some places down the steep banks, are numerous large boulders which remain and form a wall. The south side of George and Little George islands are good examples. There the boulders are of nearly uniform size, though occasionally large. All are of Archæan gneiss, schist or granite. Sandy Islands also have the same boulder beach-ridge derived from the erratics deposited on the surface of the gravel terrace.

Gravel beaches.

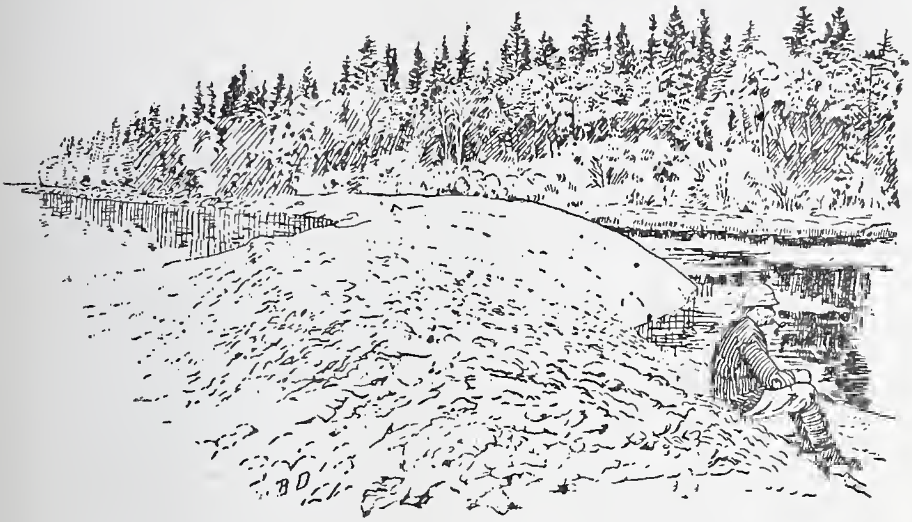
Gravel beaches.—These are either of similar origin to the boulder beaches or are derived from denudation of cliffs of rock. Owing to their being composed of smaller material, which is more easily transported, they are often found at a distance from the original deposit from which they are derived. Sand beaches also are sometimes found in the vicinity of exposures of sand or of the soft sandstones of the south-eastern portion of the lake.

Limestone gravel.

Limestone gravel beaches.—The denudation of the limestone cliffs affords abundant material at many points, and this is often found to be spread at quite a distance from the parent cliff. In the narrower portions of the lake from Dog Head south, the transportation has not proceeded far and the bars so formed are generally near the cliffs. These are sometimes useful, inasmuch as in a few cases they form small hooks, running out sufficiently far from points to form sheltered harbours for small craft, in places where there is a lack of such accommodation. At the north-western end of the Grindstone Point cliff, at Anderson harbour, a strong hook or continuation of the gravel-ridge of the shore projected into a small bay, forms a well sheltered nook. Another of the same nature is found on the point across the bay west of Bull Head at what is locally known as Boucher Point.

On Black Bear Island, the cliff at the east side affords material that has been carried along the south shore almost to the mouth of the

steamboat harbour. On its westward course this bar has already inclosed a small bay near the east end, and from low exposures of limestone near the harbour, about the centre of the south side, material is being carried into the mouth of the harbour, narrowing its entrance, and if the supply were adequate and the water not too deep, might close up the mouth.



BLACK BEAR ISLAND.

DÉBRIS FROM LIMESTONE CLIFF FORMING BAR ACROSS A BAY.

Transported bars are found on the south-east and north-west points of Little Tamarack Island, forming small hooks. At Inmost Island the smaller material, gravel and sand, from the rock exposures on the north side, are distributed in a long bar, nearly connecting this island to the mainland to the south. Transported bars.

Between Cat Head and McBeth Point, which seems to have been the end of an island, is now found a high bar of limestone gravel derived from the adjacent cliffs. This is the heaviest accumulation of its character on the lake. The Little Black Island cliffs are supplying material to form bars, running eastward to connect with Berens Island, and on the east side of Berens Island there are also examples of transported gravel bars,—one of them, ending in a small bay, forms a little harbour which was used in former times by the trading company's brigade of boats, as a rendezvous for those going west by the Little Saskatchewan River.

Transported bars are also found tailing out from several of the islands at the mouth of Sturgeon Bay and on the St. Martin Islands. Examples are also found on the west shore, north of the mouth of the Saskatchewan River, and in many cases, form small harbours. The

Transported bars.

last examples to be cited are those on Selkirk Island and the small island off the south-east corner. The harbour at the north end is formed by a heavy gravel-bar running west from the north point, then turning to follow the shore southward for half a mile. This, thus forms a long narrow bay, deep enough for lake steamers and well sheltered. Deep water is found up to the edge of the bar on the inside and the harbour has been used by the fishing companies. Another, made in the same way, is that on Pony Island, already described as forming a horse-shoe by two bars running from both sides of the island to the westward.

Gravel- and sand-beaches.

Gravel and sand beaches.—The bay at the north-west corner of the lake called Limestone Bay, is protected by a long narrow spit of sand. This may be wholly transported from the eastward, as the result of storms from the south and east in the fall. The long north shore reaching to the outlet of the lake having mostly a sand beach, would afford a large supply of material for the bar. South of Long Point the corner inclosed between it and the west shore, is being cut off by gravel- and sand-bars built from both shores, and numerous smaller examples of this, are found along the north side of the point, where many bays are already cut off. A heavy sand- and gravel-bar is found uniting two islands off Saskatchewan Point in the same manner as McBeth Point is now united to Cat Head, while near by in Lynx Bay a heavy sand-bar cuts off a portion of the end of the bay, which is now formed into a lake.

Further examples are seen at Sandy Bar, north of the mouth of Berens River and in the long bar stretching westward from Berens Island toward Little Black Island, inclosing in an angle, a shallow bay used by fishing companies and known as Swampy Harbour.

In the southern part of the lake, examples may be cited in the bars stretching west from Big Island, and a companion bar from the west shore near Icelandic River. Willow Point is also mostly built up by transported material. The small bluffs on the east end are on slightly higher ground—possibly a former island, which is now connected to the mainland by bars formed from material carried south from the vicinity of Gimli. Across the lake at Grand Marais and near Elk Island other similar examples are indicated on the accompanying map. The beaches along the south shore are partly transported and partly derived from the sifting of the delta material brought down by the Red River. The transporting agent is generally the waves, and as the direction of the storms affecting this part is mostly from the northward, the transportation effected is from both the east and west shores, converging to the centre of the bay.

J. B. Tyrrell, Photo.

NORTH SHORE OF LAKE WINNIPEG, CLIFFS OF PEAT ABOVE BEDS OF CLAY AND SAND.

GEOLOGICAL SURVEY OF CANADA
G. M. DAWSON, C.M.G., LL.D., F.R.S., DIRECTOR

REPORT

ON THE

EAST SHORE OF LAKE WINNIPEG

AND ADJACENT PARTS OF

MANITOBA AND KEEWATIN

From notes and surveys

BY

J. BURR TYRRELL, M.A., F.G.S., &c.

COMPILED BY

D. B. DOWLING, B.A.Sc.

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST
EXCELLENT MAJESTY
1900

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To G. M. Dawson, C.M.G., LL.D., F.R.S.,

Director of the Geological Survey of Canada.

Sir,—I beg to present herewith a report on the country bordering the east shore of Lake Winnipeg. This region was examined by Mr. J. B. Tyrrell in 1890 and 1891. Subsequently, in 1895, while exploring the country to the north, a survey of Gunisao River was added, thus completing the examination of the streams flowing through the country comprised within the limits of the accompanying map. Previous to Mr. Tyrrell's resignation from the staff of the Survey, he had written a portion of a report dealing with description of the Archæan rocks exposed on the lake and entering streams, as far south as Dog Head. In this I have interpolated notes on the surface deposits and general descriptions extracted from his note books, and in like manner have added a general description of the shores and entering streams as far as the Red River. The notes of Mr. A. S. Cochrane's survey of Poplar and Big Black rivers are also utilized. Thin sections of a large number of the rock specimens from this district had been examined by Mr. W. F. Ferrier, and where detailed descriptions are added, they are mainly from his notes.

The general arrangement of the report is in the form of a description from the north end of the lake southward, to the mouth of the Red River.

I have the honour to be, Sir,

Your obedient servant,

D. B. DOWLING.

NOTE—*The bearings throughout this report refer to the true meridian.*

REPORT

ON THE

EAST SHORE OF LAKE WINNIPEG

AND ADJACENT PARTS OF

MANITOBA AND KEEWATIN

General Description of the Country east of Lake Winnipeg.

The east shore of Lake Winnipeg is in marked contrast to the west. Its general outline is remarkably straight, showing the very even nature of the surface upon which the later stratified rocks of the central part of the continent were deposited. The rocks are all Archæan and the great preponderance of gneisses and granites of the Laurentian is the chief feature. Small areas of Huronian greenstones and schists occur in two localities, one on Lac du Bonnet and the other at the mouth of Wannipegow River. General description.

The general character of the shore-line differs but little from that of other lakes in the Archæan areas in which the basin occupied is of a shallow nature. Owing to the slight slope toward the lake from the east, the uneven rocky surface, as submerged, forms all along, a series of outlying islands, and off the points long lines of shoals. The strike of the rocks in some cases influences the direction of the shoals, but the major portion of the shore is apparently independent of it. One instance of the strike determining the direction of the shore is along that portion opposite Bull Head. Character of east shore.

In the northern part of the lake the prominent points run out in a north-westerly direction, and the continuation of the submerged surface is shown in long lines of shoals of which the trend is in the same direction. This character proves a serious obstacle to the navigation of the eastern part of the lake by large vessels, as harbours, though numerous, are difficult to approach unless extensively buoyed or Shoals off points.

marked. The mouths of all the large streams on which lumbering operations might be conducted are similarly obstructed. The bay into which Berens River enters is very difficult of approach, and the same is true also of the mouth of Poplar River. The outlet of the lake through Playgreen Lake is through a maze of shoals, and the steamer that makes an annual trip to Norway House seldom passes through without striking some of these, even when in charge of an experienced pilot. The following general description of the physical features of this shore and entering streams is extracted from the Summary Reports of J. B. Tyrrell to the Director for the years 1890, 1891 and 1895 :—

Difficulties of navigation.

North shore.

'Limestone Bay, is cut off from the rest of the lake by a narrow spit of sand, twelve miles in length, projecting towards the south-west. From the base of this spit an even unbroken sand-beach stretches eastward to near Mossy Point, while behind the beach is an almost vertical cliff, rising in some places to a height of forty feet, composed at the bottom of a stiff blue alluvial clay, and at the top of a mossy peat. Nelson River at the discharge of this lake flows over a bed of Laurentian gneiss which it has not worn sufficiently even to obliterate the well defined glacial striæ that may be seen on almost any of the rocks along its shore. It is, however, enlarging and deepening its channel by cutting away the alluvial point lying to the west of it, on which the storehouse of the Hudson's Bay Company is at present situated. This point, which stretches as a long narrow arm between Winnipeg and Playgreen lakes is also being rapidly worn away by the waves of both these lakes, and the time is not very remote when the site of the present narrow arm of alluvial clay and peat will be at the bottom of the united lakes.'

Outlet.

Great Playgreen Lake.

'The north-eastern shore of Great Playgreen Lake is entirely underlain by Archæan granites and gneisses, while the south-western shore is composed of the stratified post-glacial clays, which form the long, narrow point separating that lake from Lake Winnipeg. Nelson River issues from Great Playgreen Lake in several channels. On Little Playgreen Lake the rock is generally a very uniform gray granite, although at one place, near the south end, it is associated with a dark rather coarse-grained massive diorite, and near the north end of the lake, it is cut by veins of red pegmatite containing crystalline aggregates of molybdenite.'

Gunisao River.

'Gunisao River near its mouth winds without perceptible current through an extensive marsh, with a width of from fifty to one hundred yards. The water is of a dark-brown colour and slightly murky. Up to the Forks, a distance of eighteen miles the banks are low and

but scantily wooded, with a few rounded bosses of gray gneiss rising here and there. The stream is interrupted by four rapids, past two of which are portages, respectively 100 and 185 yards in length.

'Above the Forks the south branch is the larger. On this many rapids obstruct the stream, up some of which the canoe was hauled with a line, while past twenty-two of the most serious it was necessary to carry the canoe. For about fifty miles above the Forks, the river flows through a clay-covered country sloping gently towards the north-west, and has cut a channel or valley varying in depth from six to twenty-five feet. In places it has cut down to the underlying granite or gneiss, which then usually forms a barrier over which is a fall or rapid. Between these rocky rapids is slack water, and rock exposures are infrequent, and where seen are constantly of gray or reddish-gray granite. The banks are wooded with beautiful, tall, white spruce, apparently forming a magnificent coniferous forest, but how far back from the river this forest extends, was not determined. There is certainly here a large quantity of valuable timber, much more than was seen anywhere else in the country immediately east of Lake Winnipeg, for most of the surface farther south has been swept by extensive forest fires within the last decade. Good timber.

'In the upper half of the river, the banks are low and much less clearly defined. Deep bays filled with wild rice, extend between the rocky knolls back to swamps, wooded with tamarck and small black spruce, generally killed by fire.

'Gunisao Lake is a lake of clear cold water, with irregular contour, about thirty-two miles in length, and with steep, almost bare rocky shores of gray granite. The rowan bush was seen growing on some of its many rocky islands. Gunisao Lake.

'The channel of the north branch or McLaughlin River is almost as large as that of the south branch and carries about two-thirds as much water, but the banks, in the lower part at least, are rather more rocky and barren, and almost all the timber has been destroyed by fire. There are but ten portages on this river, but for long distances the current is very swift, and the river has not yet cut for itself a channel of any considerable depth. Throughout its whole course from the long narrow lake to its mouth, the river flows through a level, clay-covered country, the rock merely rising here and there in knolls and ridges above the general level. McLaughlin River.

'Along the shore from the Nelson River to Berens River, the rock is found to be Laurentian gneiss, without any constant dip or strike. Nelson River to Berens River.

It was also found to be strongly glaciated, and in several places two sets of striæ could be clearly recognized. It is generally covered by a soft, blue, imperfectly stratified alluvial clay. Belanger River for twelve miles up, to the first portage, is from sixty to one hundred yards wide, with clay banks six to fifteen feet high, wooded with white poplar and small black spruce. A low outcrop of gray granite may be seen here and there. The water is dark coloured and muddy. Above this portage the river has a width of from thirty to fifty yards.'

Belanger River.

'The river was found to rise not far from Gunisao Lake, and there is said to be a practicable canoe-route in high water from it to the lake. The current is often swift, and the channel crooked and overhung with willows. The banks are everywhere composed of stratified clay or silt, and much of the country has been well wooded, but unfortunately nearly all the timber has been destroyed by fire in comparatively recent years. Some small trees of Manitoba maple (*Negundo aceroides*), were growing by one of the lower rapids. The rock wherever seen, was a uniform gray granite."

Big Black River.

On the Big Black River, Mr. Cochrane reports the soil as excellent, and would probably produce larger timber than that now growing, but for recent forest fires. The water in the river is of a dark colour and muddy. On Poplar River the rock exposures are not so frequent, and there seems to be also the same class of good soil. Berens River as reported by Mr. A. P. Low, flows through a country underlain by granites and gneisses. The general character of the stream is very much like that of a canal where the locks are represented by narrow chutes. Pot-hole Portage on this river is thus described by Mr. Tyrrell :—'Just below a little rapid with a drop of thirty inches, at the west end of Long Lake, is a granite hill, on the south-east side of which, facing up the river, is a group of seven large pot-holes, besides several smaller ones. The most perfect is thirty-three inches in diameter and ten feet deep, with the top of the rim eight feet above the water at its base, or five feet and a half above the water of Long Lake. Some of the others have been partly cut away, and the smooth rock faces are strongly scored by glacial marking, showing that the pot-holes are of pre-glacial or inter-glacial age, when the water flowed in a direction more or less opposite to the course of the present river.

Poplar River and Berens River

Pot-hole Portage, Berens River.

'A short distance below Pot-hole Portage, a small sluggish brook flows into Berens River from the north. This brook was ascended to a shallow lake almost choked with luxuriant beds of wild rice. Near the east end of this lakelet a small crooked brook was entered, which winds through marsh and willow swamp for about three miles, to a rocky

barrier eight feet high, over which the water flows in its higher stages earlier in the season. Crossing this rock by a portage fifty yards long, the descent of what is now the Etomami River was begun. At the next portage the water runs in a rill a few inches in width. The narrow winding but constantly increasing stream was then descended for about thirteen miles, between banks of rock and light-gray pebbly till, to a series of heavy rapids, just below which is a well defined sandy terrace, marking the highest shore-line of the glacial Lake Agassiz seen on the east side of Lake Winnipeg, and the eastern limit of the lacustral deposits. This limit had been determined on several of the other streams flowing into the lake, but nowhere was it so distinctly marked as here. Below this sandy terrace, the river flows between wooded banks of lacustral sand and clay, to the point where it empties into Berens River, seven miles above its mouth. The rocky bosses seen here and there, were everywhere of uniform granite and granitoid gneiss.

Pigeon River.

'Pigeon River flows into the lake in a deep channel, a hundred yards wide, between sandy points, above which it opens into a shallow weedy lake. Around the sides of this lake were beds of wild rice, then almost ripe, on which great flocks of wild ducks were feeding. The channel gradually narrows and becomes well defined at a little rapid, where it is about forty yards wide, above which it again expands to a width of from sixty to a hundred yards with even, clay banks, six to ten feet high, wooded with tall white poplars. Low bosses of gray gneiss outcrop here and there, on which are growing small groves of oak.

'The work of ascending the stream was rather slow and difficult for the Indians rarely travel on the river, and the twenty-nine portages that we were obliged to make were often through dense burnt forest and over innumerable fallen trees. In its lower part, the banks are chiefly composed of stratified clay or sand and the channel is even and well defined, but higher up the banks are of gneiss or pebbly till. From Grand Rapids Lake, [Family Lake] Pigeon and Berens rivers, two streams of about equal size, flow westward towards Lake Winnipeg, the former discharging from the south, and the latter from the west side of the lake.'

Miskowow River.

'Miskowow River, near its mouth, averages from forty to fifty yards in width, with water of a slight brownish tinge but not dark-brown like most of the other rivers east of Lake Winnipeg, indicating that it is derived chiefly from lakes of considerable size, in which the water has been cleared of its dark colouring matter. The banks are no

very high but are usually rocky, and the water often seems to flow in a pre-existing rocky channel. Between the rocky knolls and ridges, the blue, stratified, lacustral clay that is seen everywhere in the lower country east of Lake Winnipeg forms well-defined level land, thickly wooded with white poplar, while the rocky knolls are thickly wooded with Banksian pine and oak.

Pot-holes.

'At the fourth portage up the river, three pot-holes, similar to those on Berens River, occur on the summit and south-west side of a granite knoll, and farther up the river, above the ninth portage, and about half-way between the mouths of Minago and Little Blood-vein rivers, a large pot-hole has been bored in the steep eastern side of a granite hill, the surface of which is now strongly scored by glacial markings. Sasaginnigak Lake is an irregular body of clear water lying in the midst of low hills of gray granite. From this lake there is said to be an easy canoe-route northwards to Grand Rapids on Berens River.'

Berens River to Dog Head.

'The shore of Lake Winnipeg from Berens River south to Dog Head is composed of granites and gneisses generally striking towards the lake but at the latter point these gneisses begin to assume a very regularly banded arrangement parallel to the lake, and a few miles farther south, dykes of dark-green trap begin to make their appearance, running in the same direction. Then irruptive rocks continue close to the east shore as far south as Wannipegow or Hole River, where they merge into an extensive area of eruptive volcanic rocks and agglomerates that form the base of the Keewatin series. On ascending the streams that flow into this portion of the lake, namely, the Loon, and Rice rivers, the gneiss is seen to be very regularly and evenly banded near the eruptive rocks, while farther east it changes imperceptibly into the coarse gray irregularly foliated Laurentian gneiss typical of that whole region. The rocks of the eastern end of

Black Island.

Black Island were found to consist of altered conglomerates, quartzose sandstones, agglomerates, chloritic and sericitic schists, etc., similar to those found in the typical Keewatin in the Huronian districts elsewhere. The quartzites and conglomerates are somewhat more easily eroded than the adjoining volcanic rocks, and they therefore lie in a hollow, which is flanked on one side by Black Island, and on the other by the east shore, the beds standing generally at a high angle and striking parallel to the general curving trend of the shore.'

Wannipegow River.

'Wannipegow or Hole River at its mouth breaks through a belt of evenly banded gneisses, above which it flows for ten or twelve miles through a rich alluvial plain wooded with poplar and white spruce,

the banks on either side rising to a height of from fifteen to twenty feet above the water. Very little rock is to be seen but any exposures that do outcrop from beneath the till and alluvial deposits consist of massive coarse amphibolites and green chloritic schists. On the lake above, the rocks are almost entirely of the same character, though at some places on the north shore the gneiss approaches close to the water, and the contact of the green schists of the Keewatin and the Laurentian gneiss is well shown. Speaking generally, the lake and valley of the river lie in a trough of Keewatin schists, the north side of which is bounded by ridges of Laurentian granites and gneisses, while the south side rises in hills of more compact green schist.

'A tributary, the English River, in its lower portion also flows over Keewatin schists, but the lowest rapid occurs at the contact of the schist and gneisses, and above this its course is through rugged country composed of high barren hills of gray gneiss, thinly wooded with a stunted growth of small Banksian pine. Specimens of galena and chalcopyrite, stated to have been found on the north shore of Wannipegow Lake were shown to the writer, and the occurrence of these minerals is not improbable along the above mentioned contact line.'

English River.

'From the mouth of Wannipegow River to Manigotagan or Badthroat Bay the shore is composed of greenish-gray evenly banded gneisses, with schists and altered traps of the Keewatin series, while near Clement Point these are overlain by Winnipeg sandstone, this latter being the most northerly point at which Palæozoic rocks have been recognized on the east side of the lake.

Clement Point.

'Manigotagan River is remarkably picturesque throughout, consisting of long quiet stretches of clear brown water, separated by rocky rapids or high abrupt falls, which are passed on portages of an average length of from one to two hundred yards, twenty-three of which must be ascended on the way from Lake Winnipeg to Rat Portage Lake.

Manigotagan River.

'From the mouth of Manigotagan River to Point Metasse, north of the mouth of Winnipeg River, granites and gneisses everywhere compose the points on the shore, and these points are usually connected by gently curved sandy beaches in front of low-lying alluvial land.

'On Winnipeg River the rocks are all granites and gneisses, but towards the east end of Lac du Bonnet and around the mouth of Oiseau River, thin-bedded green schists and altered traps, doubtless of Keewatin age, make their appearance, striking up the valley of the latter stream. Above the lake on the main river, the banks, as far as

Winnipeg River.

the mouth of Whitemouth River, are chiefly composed of till, with many limestone boulders, and the rocks are scored in a south-south-easterly as well as a south-westerly direction, showing that the earlier glacier moving south-eastward over the Palæozoic Lake Winnipeg basin, had extended at least this far eastward, though there is no sign of limestone drift on the main portion of Lac du Bonnet itself or on the lower part of Winnipeg River.'

DETAILED DESCRIPTIONS OF THE COUNTRY BORDERING THE EAST SIDE OF LAKE WINNIPEG.

Playgreen Lake.

Rocks of islands in Great Playgreen Lake

Off the west point of the island lying N. 12° E., from Warren Landing are rounded knobs rising a foot or two above the water. They consist of brownish-gray gneiss, cut by a dyke of red granite six feet wide, from which smaller veins extend in all directions. The bearing of the main dyke is generally S. 56° E., but at one place it runs for ten feet at right angles to this. It is distinctly banded, being coarser in the middle, and usually finer toward the sides.

Island south of Kettle Island.

The island south of Kettle Island is composed of dark moderately coarse-grained quartz-mica-diorite-gneiss, with a very irregular lamination, striking for the most part about N. 45° E., but in one place S. 70° E. It is composed of plagioclase felspars, microcline, quartz, biotite, hornblende, a little augite, with apatite, zircon, pyrite and titanite. Under the microscope it is evident that plagioclase is the most abundant felspar present, only a few untwinned grains being visible in the section. The plagioclase is much decomposed, fine tufts of kaolin and sericite occurring throughout the grains of this mineral, and in some cases the alteration is almost complete. Some of the grains show uneven extinction. Between some of the larger grains of felspar are granophyric areas. The quartz is of the usual granitic type, much crushed, and exhibits very uneven extinction. It holds dust-like inclusions with bubbles, etc. The biotite is dark-brown in colour and strongly pleochroic, and is in part altered to chlorite, some of the grains showing complete alteration, while others show chloritization in streaks only. It holds numerous minute crystals, probably rutile, with a sagenitic arrangement. Zircon crystals also occur in it, surrounded by well-marked pleochroic halos. The hornblende is in very small quantity. Apatite occurs in rather stout crystals scattered through the section, and pyrite is found in well-defined crystals.

Microscopical character of rock.

This gneiss includes many rounded and angular masses, up to five feet in diameter, of a dark fine-grained hornblende-granitite-gneiss, containing crystals of primary epidote, the line between the two gneisses being sharply marked, though the former often shows a distinct lamellar structure around the masses of the latter. Both gneisses are cut by many dykes of red granite ranging up to fifteen feet wide, the larger ones being near the west side of the island.

Three miles north of Warren Landing is a low bushy island formed of coarse white granite, with irregular inclusions of darker gneiss.

Half a mile east of Kettle Island is a low scrubby island where the reddish-gray gneiss strikes S. 70° E.

Kettle Island is composed chiefly of gray granitoid gneiss, through which are scattered rounded inclusions, from a foot to several yards in diameter, of darker gray gneiss. On a low island a mile and a half north of Kettle Island the gneiss is heavily laminated, running S. 75° E. Kettle Island

On the east side of Goose Island is an outcrop of fine-grained dark-gray quartz-mica-diorite-gneiss, composed chiefly of plagioclase, biotite, quartz, muscovite, and orthoclase, with epidote, apatite, zircon, magnetite and chlorite. The rock shows distinct evidence of pressure, the quartz being fractured, and showing wavy extinction. Plagioclase is present in large amount. There are also some grains of untwinned feldspar, which may be orthoclase, and a few grains that exhibit the characteristic twinning structure of microcline. Goose Island. Lithological description.

Biotite is the principal bisilicate present, it is light-yellow to brown in colour and strongly pleochroic. Associated with it is a considerable quantity of colourless muscovite. Small zircons, showing the pleochroic halos so often noticeable, occur in the biotite. Apatite is in large, short, stout crystals. Magnetite is rather abundant. Chlorite occurs as a decomposition product of the micas.

Lying against this diorite-gneiss in an irregular line bearing generally north-and-south, is a very lamellar micaceous gneiss, striking east-and-west and almost vertical. Between the lamellæ are included many masses of darker fine-grained dioritic rock, all more or less drawn out in the direction of lamination. These various rocks are cut by banded veins of pegmatitic granite, usually running about N. 45° E.

On the east side of the island are two narrow veins, striking N. 10° E., of fine-grained dark-green compact quartz-diabase, which under the microscope is seen to consist of a fine-grained felspathic and chloritic

groundmass, through which are distributed numerous lath-like crystals of a more or less decomposed plagioclase. Quartz and augite also occur.

Islands near Goose Island.

A third of a mile north-east of Goose Island, is a small island of light-gray gneiss striking S. 85° E.

A small island almost a mile north-north-west from Goose Island is composed of a dark-gray moderately fine-grained almost massive gneiss, with a few porphyritic felspar crystals scattered through it. It possesses a somewhat distinct lamination, striking N. 20° W., and dipping N. 70° E. < 55°. It is also cut by a series of almost vertical jointage planes running north-and-south, breaking the rock into masses from one to two feet in thickness. Some veins of red pegmatitic granite also cross this island in a direction N. 45° E.

Lithological descriptions.

Under the microscope, the gneiss is seen to be a tolerably fresh holo-crystalline rock, consisting of quartz, plagioclase, orthoclase, hornblende, biotite, augite, titanite, epidote, magnetite, zircon, chlorite, apatite and pyrite. Small areas showing granophyric structure occur between many of the felspar grains. The quartz is of the ordinary granitic type, holds numerous inclusions, and in its fractured appearance and wavy extinction shows evidence of having been subjected to dynamic action. The felspar occurs in both twinned and untwinned grains, many of which show more or less kaolinization; it holds numerous inclusions. Hornblende is the most abundant bisilicate present. It occurs in strongly pleochroic individuals, dark-green to lighter in colour. Many of the individuals are twinned and well defined in their crystallographic boundaries. A striking feature of the section is the abundance of titanite present in it. The epidote occurs in quite large individuals, which in some cases include apatite and magnetite. Its pleochroism is quite marked and the interference colours are brilliant.

Playgreen Point.

Playgreen Point is a rocky promontary of dark hornblendic gneiss striking N. 60° E., cut along the lines of foliation by heavy bands of coarse reddish-gray biotitic granite.

The islands towards the north and north-west of Playgreen Point are all rocky knolls composed of very similar gneiss.

The large island near the north-west side of the bay is of a medium-grained gray hornblende-granite cut by wide veins of red pegmatite.

West of the most westerly channel into Little Playgreen Lake is a low point surrounded by rocky reefs, and composed of reddish-gray gneiss foliated N. 60° W. Catfish Point is very similar in character,

consisting of light-red gneiss striking N. 75° E. and dipping S. 15° E. < 60° In the next seven miles along the west shore of the lake, very few exposures of rock were seen, and then the lake bends to the north around a low rocky point composed of a reddish-gray dioritic gneiss striking S. 40° E., while a number of low reefs of similar rock lie off the point. The bay to the north-east is also studded with islands of similar character. One long point near the bottom of the bay consists of reddish-gray gneiss, with some highly biotitic bands, striking N. 70° E., and dipping S. 20° E. < 60°. On the north side of the bay, where the main channel of Nelson River flows from Playgreen Lake, the rock forming the bed and sides of the channel is a well-foliated reddish-gray biotitic gneiss striking N. 50° E. and dipping S. 40° E. < 25°. Catfish Point.

Channels between Great and Little Playgreen Lakes.

The banks of the steamboat channel consist of reddish-gray gneiss, almost massive in texture, rising in rounded bosses from the edge of the water up to the height of thirty feet. The eastern channel is very similar in character, with low rounded rocky banks of Laurentian gneiss.

Little Playgreen Lake.

Little Playgreen Lake is divided into two fairly distinct portions by a narrow strait just north of Soulier Point which is a rocky knoll consisting of gray granitoid gneiss, striking N. 75° E. Soulier Point near Norway House.

North of this point is a small island, composed, on the north side, of a dark-gray biotitic gneiss cut by many reticulating veins of a reddish granite, while along the south side of the island, and separated from the gneiss, just mentioned, by a strongly marked line of contact, is a massive red and greenish-gray, mottled, rather coarse-grained hornblende-granitite, in which are many inclusions of the darker gneiss.

Under the microscope this granitite is seen to be a thoroughly crystalline granular admixture of quartz, felspar, biotite, more or less altered to chlorite, and hornblende, with epidote, zircon, pyrite, magnetite and apatite. The rock exhibits abundant evidence of dynamic action. The quartz and felspar are much shattered, the quartz being in many instances so ground up as to form a fine mozaic. The felspar is much kaolinized, and both minerals possess very wavy and uneven extinction. The zircon is in large individuals with a curious clove-brown colour. Lithological description.

A quarter of a mile west of Soulier Point is a small island composed of red granitite which is here definitely foliated N. 65° E. It also includes many large masses of the dark-gray gneiss.

Islands of Little Playgreen Lake.

South-west of this island are other islands composed of similar and hornblende-granitite-gneiss. One, a mile and a half distant, and on the edge of the open lake, being more particularly examined, was found to be a coarse granitite-gneiss, with a lamination, dipping N. 50° W. $< 11°$, and in many places a well marked schistosity striking S. 80° E. It consists of quartz, felspar much of which is microcline, biotite, hornblende, apatite, zircon, epidote, allanite, chlorite, and magnetite. The rock presents abundant evidence of crushing, and granophyric structure is widespread. The apatite occurs as a primary constituent, in large grains, in some cases with clearly defined crystal faces, mantled by unaltered biotite. The granitite is cut by a number of veins of red granite, and on the south side of the island contains many inclusions of dark-gray biotitic gneiss.

South-west portion of Little Playgreen Lake.

Proceeding south-westward, the south-east shore of the lake is everywhere composed of similar granitite, often with darker inclusions, and almost constantly cut by veins of red pegmatite.

Six miles and a half from Soulier Point the granitite was found to be cut by a dyke or mass of rather coarse-grained massive diorite or diabase.

Similar red granitite extends all along the west shore of the south-western expansion and forms the shores and islands of the northern portion of the lake. On a small island nearly a mile north of Norway House, this hornblende-granitite is massive, reddish and of medium grain. Under the microscope, the structure of the rock is seen to be typically granitic, and the section exhibits abundant evidence that the rock has been subjected to considerable dynamic action. Both the quartz and felspar are much shattered, forming a regular mosaic, with numerous well-defined areas showing granophyric structure and exhibit uneven wavy extinction. The felspar is more or less kaolinized. The rock is composed of quartz, orthoclase, plagioclase, hornblende, biotite, a few small grains of titanite, zircon, apatite, in well defined rather stout prisms, epidote, and a little iron ore.

Molybdenite crystals.

Near the north end of the lake, just below where the Nelson River flows from it, the granitite is cut by some veins of red pegmatite, in some of which are many rounded crystal aggregates of molybdenite, with occasional crystals of pyrite and magnetite.

J. B. Tyrrell, Photo.

VIEW AT NORWAY HOUSE, KEEWATIN, SHOWING CHARACTER OF SURFACE OF THE ARCHÆAN.

Gunisao River.

The country in the immediate neighbourhood of the mouth of the river is very low and flat. Marshy banks extend for over a mile from the Nelson River and thence upward the country slopes very gradually, not rising much above the channel of the river till past the forks. Gunisao River.

On the south branch the gradual slope is carried to nine miles east of the forks where a steeper ascent is met. On the lower plain a light covering of alluvial clay is seen occasionally in the depressions and has probably all been carried down by the river. On this the timber is heavier than that seem on the higher parts, and spruce up to twenty-four inches in diameter was noted. Character of country below the forks.

In the vicinity of the mouth of the river the rock is a gray granitite-gneiss cut by veins of red pegmatite-granitite. The foliation of the gneiss becomes less distinct, until at the second rapid, it has entirely or almost entirely disappeared, and the rock is quite massive.

Similar gneiss underlies the country up to the forks, and thence, up the north branch of the river, it may constantly be seen cropping out from beneath the covering of clay, sometimes massive, and sometimes distinctly foliated Two miles and a half up this branch, named Mc-Laughlin River on the map, there is a band of medium-grained, gray, rusty-weathering-granitite gneiss, with very distinct foliation, dipping north at an angle of 30°. At a portage two and a half miles higher up the stream, the rock is a massive granitite, varying to a highly contorted gneiss. McLaughlin River.

Thence up the stream for a considerable distance the rock changes but little in general character, though it may vary somewhat in colour and texture, and foliation may or may not be noticeable.

In longitude 97° 30′ W., the gray granitite is replaced by a massive red medium-grained granite, which often contains included masses of dark-gray granitite-gneiss, and is, therefore, probably somewhat newer in age than the latter. In some places it contains large crystals of magnetite. This red granite extends up to, and past, the first small lake, when the light-gray well-foliated gneiss re-appears, striking N. 60° E.

Near the second small lake, rocky ridges run on each side of the river; composed of a gray gneiss in which plagioclase felspar has so largely replaced the orthoclase that the rock might be classed as a quartz-mica-diorite. It strikes S. 75° E., and has an almost vertical dip. This light-gray granitite or quartz-mica-diorite, forms the shore of the second small lake, and extends for a mile eastward to where the

McLaughlin River.

river again divides into two almost equal branches, each about fifty feet wide. The surrounding country is here exceedingly desolate, consisting of bare, low rounded knolls of reddish granite and gneiss with a general elevation of sixty feet above the river, the gneiss having a general strike N. 60° E.

The banks are low in this vicinity, and composed of gray silt for a considerable distance, but five and a half miles above the last-named lake, the river expands into another small lake, three-quarters of a mile long, in the middle of which is an island of a dark-gray and greenish, highly altered, hornblende-schist, with a foliation striking N. 55° E., but this foliation is usually very irregular, and is often replaced by an ovoidal or concretionary structure.

Magnetic attraction.

A mile above this lakelet we passed a low hill, beside which the compass refused to work with any regularity, and a quarter of a mile higher up the stream, is an outcrop of dark-gray thinly and regularly foliated hornblende-schist, striking N. 70° E., and with a vertical dip. Its surface is very deeply weathered.

A mile above this point, and on the west side of the river, is a rounded hill sixty feet high, of light-gray thinly-foliated garnetiferous muscovite-granite-gneiss, rather irregularly interbanded with dark-gray hornblende-schist or biotite-schist, all striking N. 75° E.

For nine miles above this point, the river continues to come from an east north-easterly direction, following this band of schist, which crops out here and there along its banks.

Robinson Lake.

Robinson Lake, from which the river takes its rise, lies in a depression from which these schists have been worn out, and horn blende-schist, occasionally with interbedded granite veins, everywhere forms the shore of the long narrow lake. From the upper end of the lake the same valley continues in an east north-easterly direction an unknown distance, doubtless following the trend of this band of schist.

Gunisao River above forks.

Ascending the south branch of Gunisao River the banks are at first of clay and very little rock is exposed. Five miles above the forks is a rounded boss of light-gray massive biotite-granite ; although as plagioclase would seem to be the chief felspar constituent, it might perhaps be classed as a quartz-mica-diorite. Similar granitite outcrops rather more than half a mile higher up the stream, and again two miles and one-fourth above. At a thirty yard portage this granitite exhibits a slight gneissic foliation.

Three-quarters of a mile higher up the stream are banks of rather high rounded rocks over which is a portage one hundred yards long.

The rock is a massive, coarse, gray granitite or quartz-mica-diorite with here and there included masses showing gneissic structure.

Across the west side of the knoll this rock is cut by a narrow dyke, averaging fifteen inches in width, dipping vertically, and striking N. 23° E. Branches several inches wide constantly run off into the surrounding granitite and end abruptly. The dyke has a strongly marked columnar structure, running transversely from wall to wall. The dyke-rock is an augite-porphyrite of a light greenish-gray colour. It has a mica-felsitic groundmass in which sericite is abundantly developed, giving the rock its colour, and through this are scattered many little bright phenocrysts of light-coloured pyroxene (augite) more numerous near the sides of the dike than in the middle, a few small and irregular phenocrysts of plagioclase, many small rounded crystal aggregates of arsenopyrite, and some secondary muscovite and zoisite. Rocks at various portages.

At another thirty-yards portage, a mile and a quarter above the last portage, the rock is again a massive light-gray quartz-mica-diorite. At the next portage three miles and a half above this the rock is a massive medium-grained biotite-muscovite-granite, of light-gray colour very similar to the quartz-mica-diorite previously found.

The banks above this portage became more bare and rocky than below it, and the quartz-mica-diorite becomes distinctly foliated; at the portage (twenty yards) it strikes N. 80° E. and dips S. 10° E. $<$ 30°.

For eight miles above this portage, to the next portage which is thirty yards long, the rock is everywhere a very similar gneiss, with essentially the same strike throughout the distance. On the north bank is a cliff twenty feet high, showing at the top eight feet of fine, gray sandy clay apparently with very few boulders, and below it for several feet and probably to the water, is well stratified sand and coarse gravel; the pebbles being from the Laurentian rocks. The country just passed through appears to be largely of the nature of a sand-plain through which the river has cut a small valley.

Rather less than half a mile above the last portage is a fall with a drop of eight feet, at which the rock is a light-gray medium-grained granite showing in a few places a very slight foliation striking N. 70° E. Three miles higher up, the river again falls over a fine-grained light-green granite which is usually slightly foliated, N. 80° E. Half a mile above is another fall, past which is a portage three hundred yards long. The rock is a similar gneiss, in Falls.

places thinly and clearly foliated, and in others obscurely foliated the strike varying from N. 35° E., at the west end to N. 80° E. at the east end of the portage.

Wooded plains.

For the next six miles very little rock is seen, the river running through rich wooded plains rising gradually and varied here and there by rocky knolls, but above this the rock becomes the predominating feature and the plains are merely the bottoms of the shallow depressions between the hills. Boulders continue to be rare, and sand is seen here and there, but the depressions in the rock appear to be almost everywhere filled by a very light-gray, fine, almost impalpable clay. Instead of large spruce, with white and black poplar, the whole country is thickly overgrown with small black spruce, which a few years ago was killed by fire, so that now there is nothing but blackened stems with a thick growth of underbrush. The first exposure in the rocky part is at a succession of small falls over a foliated reddish-gray gneiss, with vertical dip, and a general easterly strike. The banks now become bold and rocky, and continue so for a considerable distance. At a portage seventy yards long, two miles higher up the river, the rock is a gray quartz-mica-diorite, of medium grain, and well foliated, striking east and with nearly vertical dip.

Rocks near Gunisao Lake.

Two miles and a half above this portage, in latitude 53° 35′ 10″, is a boss of gray moderately coarse-grained garnetiferous quartz-mica-diorite, associated with a red granite of medium grain. The burnt country ends about five miles above this, and is succeeded by a tamarack swamp through which rise many low rounded bosses of granite. For all the rest of the way up to Gunisao Lake, a distance of about thirty-five miles, the river winds between banks composed of massive, gray quartz-diorite, which forms low rounded hills, seldom rising more than thirty feet above the general level. After the river turns south-eastward toward Gunisao Lake, the country begins to look a little more pleasant, with Banksian pine and white poplar along the banks and on the rocky knolls. The white clay disappears and a few perched boulders are, for the first time on this river, seen resting on some of the rocky knolls, all of rock similar to that beneath, showing very little transportation.

Three miles below the lake, the diorite is cut by two dykes, six feet in width, of dark-green fine-grained gabbro, striking S. 80° E., and dipping S. 10° W. $<$ 75°. Along the edges they show distinct traces of foliation, but towards the middle they are quite massive. In the specimens of this gabbro collected, the augite was found to have been entirely altered to hornblende.

The south shore of Gunisao Lake rises either in steep cliffs to a height of from thirty to fifty feet, or is low and flat, the rock sloping gently to the water. The bays have a beach of rounded boulders and the rock can be seen in many places to be overlain by a light-gray clay with angular stones and many rounded boulders, all from the Laurentian rocks. Glacial grooving may be seen in many places, but the rock is so much weathered that only the coarser markings remain. The whole country is thickly covered with black spruce. The north shore is much more rugged than the south side, and has very little vegetation on it. It is also skirted by fewer islands and indented by less irregular bays. The rocks exposed are everywhere of similar coarse gray quartz-mica-diorite, which is often vertically jointed, thus forming steep or vertical cliffs. At one place near the north-eastern end of the lake, a slight foliation was observed in the diorite, with a strike S. 75° E. Gunisao Lake

On Gunisao River, above the lake, the rock is, at first, a diorite similar to that on the lake, but it soon becomes more acid, and changes into, or is replaced by, a reddish massive, often garnetiferous granitite. River above lake.

The shores of Kapmatasko Lake which lies to the south-east of Gunisao Lake, are generally low, and at the points show low outcrops of this granitite, which is almost everywhere massive, but at one point near the north end of the lake it showed a slight foliation striking N. 70° E.

Shore of Lake Winnipeg—Nelson River to Dog Head.

Beginning at the head of Nelson River, and proceeding southward, the shore is usually composed of low cliffs of stratified post-glacial clay and peat, with rounded bosses of rock projecting here and there from beneath it, and often skirted by many low bare rocky islands.

Two miles south of Nelson River the rock is a coarse reddish hornblende-granitite-gneiss, without well-defined schistosity, but in bands differing slightly in colour and fineness. These bands have a general strike N. 85° E., and an almost vertical dip. East shore near Nelson River.

Montreal Point is composed of a rather fine-grained dark-gray granitite-gneiss, with an even parallel foliation trending N. 70° E. In many places this gneiss is cut by wide anastamosing veins of coarse light-gray granite holding crystals of tourmaline, &c. In places the granite forms the greater portion of the mass of the rock, the darker gneiss appearing as irregular inclusions scattered through it. Both Montreal Point.

the granite and the gneiss are again cut by smaller granite veins. A number of small rocks of similar granite or gneiss lie off this point.

Glaciated surfaces.

The surface is beautifully smooth and rounded and shows parallel striæ running S. 35° W. In one place, for about three yards in width, there is a more or less regular set of grooves running N. 45° W., rising up to the top of the knoll and then vanishing. They overlie the others and point directly out into the lake. They have been caused by the shoving of a single mass and may possibly have been recent, but as the shove would appear to have been toward the lake, this does not appear probable. Numerous little islands lie off the points to the south for some distance, though the points themselves are mostly of sand. For the rest, the shore is mainly sandy, though occasionally scattered with a few pebbles and boulders. The boulders are all of gneiss and granite, but a few of the pebbles are of cream-coloured dolomite. Behind the beach is a cliff gradually declining southward from eighteen to eight feet, but its face is piled with drifting sand and there is often a little sand dune along the top. A mossy muskeg with spruce and tamarack stretches everywhere backward from the lake.

Stratified deposits.

The shore, south to Spider Island Point, is being cut into by the waves, and now shows one to two feet of stratified beach-sand overlying a little vertical cliff two feet high of stratified, blue, tenacious clay breaking out into little angular fragments. Just north of the point similar gray granite, often with a green tint but with no inclusions, is cut by many veins of red granite. High sand-dunes are piled up at the edge of the woods. A little rill of brown water here runs into the lake.

Farther south, the shore is similar, being low and flat. The beach is covered with sand without boulders. Much of the beach is underlain by clay, while tree trunks erect and projecting at the edge of the water, probably indicate erosion into an old swamp. The land declines so that it is but two feet above the water, becoming a mossy muskeg that reaches Spider Island Point.

South of Montreal Point.

Four miles south of Montreal Point is a light-gray coarse-grained compact granitite, in which are many inclusions of a darker finer-grained granitite-gneiss, these inclusions being almost all arranged in strings in an east-and-west direction. Some small veins of red granite run parallel to these, and beside and parallel to them a certain amount of schistosity is often developed in the light-gray granitite. Other narrow veins of red granite also cut the rock very irregularly. The surface is smoothed and shows many glacial striæ running S. 35°

W. The bottom and the water here is very muddy, much more so than to the north.

Three series of veins.

A point two miles farther south is composed of similar light- and dark-gray granitite, which is cut by anastamosing and crossing veins of red pegmatitic granite, breaking the rock very irregularly. Three series of these veins were recognized, the newer slightly faulting the older ones. Their general directions were as follows:—First and oldest, S. 50° E.; second, S. 45° W.; third and newest, S. 10° W.

At the next point, in latitude 53° 33′, similar rocks, cut by granite veins, also occur. One dark band, here composed of hornblende-granitite-gneiss, is eight feet wide, and dips N. 40° E. < 35°. Along its contact with the surrounding gray granitite, and along little fissures cutting across it, epidote is largely developed.

Spider Island Point.

At Spider Island Point, in latitude 53° 30′, the rock is a dark-gray epidote-hornblende-granitite-gneiss, with a slightly greenish hue on the weathered surfaces. In general character it is very similar to the granitite-gneiss seen so often along the shore farther north, and has a well-marked strike varying from N. 35° E. to N. 50° E. A quarter of a mile north-east of this point the gneiss is cut by two narrow vertical dykes or veins of green hornblende-schist striking N. 80° E.

At the mouth of a little creek, a mile south-east of Spider Island Point, similar granitite forms the shore, in some places quite massive, and in other places well foliated, though the strike of this foliation is very irregular. Many veins of red pegmatite cut across the granitite, and the foliation often bends round toward the veins.

A few narrow vertical bands, or long lenticular masses of dark-gray thinly-foliated epidotic hornblende-granitite-gneiss cross through the granitite in a direction S. 85° E. At several points between this creek and the mouth of Belanger River, similar gray gneiss juts out in rough-topped knolls. The foliation, which is more or less nearly vertical, is distinctly marked, some of the layers being much darker and more micaceous than others.

Spider Islands.

The Spider Islands, which lie from one to two and a half miles off shore, are bold granitic rocks rising abruptly out of the lake. The largest, which was that particularly examined, is composed of a well foliated, gray granite-gneiss, with darker and lighter bands through which run little veins of red pegmatitic granite. The foliation is much contorted, but seems to have a general strike S. 40° W., parallel to the longer diameter of the island, while its dip is approximately vertical. Across the narrow neck connecting the

two ends of the island the gneiss is cut by a straight vertical dyke, from two to four fect wide, of dark-green schist, probably resulting from a diabase. This schist, being softer than the gneiss, is much weathered away, leaving a sharp gash through the neck of the island.

Rocks south of Belanger River.

Half a mile south of Belanger River is a point composed of gray granitite-gneiss, the foliation of which appears to strike about N. 45° E., and to dip at an angle of 70°. On the south side of the point the foliation is not so pronounced, but there is a fairly definite line ararrangement of the crystalline constituents of the rock, which gives the surface a fibrous or thread-like appearance. Veins of coarse red pegmatite are common throughout the rock, and the gneiss is also cut by a vein or dyke from eight to ten feet wide, of moderately fine-grained red granite.

A mile from this, up the shore, there is a projecting ridge of rock composed of a coarse, gray granitite-gneiss, sometimes showing a slight foliation striking N. 5° E., but often massive. Veins of both fine and coarse red granite cut this gneiss.

Belanger Point.

Belanger Point is also composed of a similar granitite cut by granite veins. The surface is weathered rough, but the glacial grooves are seen running S. 18° W. The direction of striation changes slightly along the shore here from the north, since at Montreal Point the direction was nearly S. W.

Rocks of shore south to Big Black River.

At a point in latitude 53° 24′ 30″, a boss of coarse, red pegmatitic granite projects 250 feet from the shore. It contains white mica, either as small radiated masses, or as individual crystals up to five inches in length. On the south side of the boss the rock assumes a very coarse, brecciated appearance, and sixty paces farther south it is usually finer-grained and exhibits a more or less distinct foliation, and also contains angular inclusions of gray gneiss.

The shore all along is low and sandy with a low marshy country behind. The stream that flows in here is only eight feet wide where it crosses the beach, but most of it reaches the lake through the sand. 270 paces farther south coarse, gray gneiss again forms the shore. This gneiss is sometimes almost massive, but it includes some bands of highly micaceous gneiss. It is cut by veins of red granite.

In latitude 53° 23′ 30″, the points consist of greenish-gray, coarse, quartz-mica-diorite, which is usually massive, though occasionally exhibiting a slight foliation that varies in direction from north to northwest. Included in it are a few small stringers of coarse mica-schist or granitite. Pegmatite veins are notably rare, but one coarse

vein contains, along its middle line, many fine large crystals of white mica. The diorite is also cut by some bands of light-green epidote.

Between Belanger Point and Big Black River.

Half a mile farther along the shore, pegmatitic veins again became fairly numerous, and among them is a vein of fine-grained granite-porphyry from one to two feet in width. The diorite is also here cut by a band eighteen inches wide of dark hornblende-schist, striking N. 32° E., and 400 yards farther north-east is a band of hornblende-granite striking N. 75° E., while the diorite itself has an indistinct foliation N. 15° W.

At a point in latitude 53° 22′ 30″, low reefs run out. The rock here has a rough surface, but 300 yards back there is a low outcrop of gneiss the surface of which is beautifully planed and glaciated and not weathered, having been comparatively lately uncovered from its mantle of hard, blue clay. Most of the glacial striæ run S. 26° W., but in two places the smooth surface with these striæ cuts an older smoothed surface at a sharp angle. This surface is also striated though the striæ are not so fresh and clear as the others and run S. 48° W., making thus an angle of 22° between the two sets.

A point in latitude 53° 21′ 45″, is composed of gray dioritic gneiss, without pegmatite veins, but the gneiss includes masses of darker gneiss drawn out in a direction N. 85° E., and similar conditions prevail at a point a mile farther south, though the inclusions here usually lie N. 35° W. Three-quarters of a mile farther south, a band of similar dark-gray gneiss runs N. 60° W.

In latitude 53° 21′ is a low clay point from which shallow water with a soft clay bottom, stretches out for a long distance. This is protected by innumerable little bare granite reefs lying off the shore and in the bay to the south. Behind the point is a mossy muskeg with about two feet of peat underlain by blue clay. There are very few boulders in the shallow water, but a number are collected around a rocky boss, south of the point. This is composed of massive gray granite, in which there are a few inclusions of a darker colour drawn out N. 15° W. The next point south is formed of massive, gray gneiss with a roche moutonnée surface roughened by the weather. It is cut by one narrow band of fine-grained dark gneiss striking N. 60° W., but it has no inclusions and no veins of red granite. Like all the other exposures, its lee side is abrupt and broken, while the stoss side is rounded. From this point southward for several miles the shore is shoal, but the numerous rocky islands seem to be all composed of gray gneiss similar to that farther north, cut by few, if any, veins of pegmatite.

In latitude 53° 16′ 15″, the rock is a coarse-gray granitite or quartz-mica-diorite, without distinct foliation, but containing a few darker inclusions drawn out in a direction N. 65° W., and traversed by a very few narrow veins of coarse red pegmatite.

For four miles southward the rock is a similar gray gneiss, occasionally with a distinct foliation varying from N. 45° to 65° W.

Spotted rocks near Ducks Nest.

At a point called Ducks Nest there is an area of spotted rock about thirty feet in diameter, in the gneiss, having the appearance of a conglomerate in which the pebbles are a dark-gray gneiss, while the matrix is a lighter gray running in narrow bands between, and being harder, stand out in little ridges. The pebbles are lenticular, being sometimes a foot or more in length, and lie north-and-south, or nearly transverse to the strike of the gneiss. The appearance of the rock suggests a similarity to the so-called leopard rock. Dr. A. E. Barlow thus describes it:—

Lithological description by Dr. Barlow.

'The hand specimen shows a dark-gray, medium-textured rock, traversed by small pegmatite-like dykes of coarse, reddish to greenish epidotic granite, the whole apparently representing a complex intrusion of one rock through the other, the granite evidently being the latest. Under the microscope, the most basic phase of the rock shows a holocrystalline admixture, composed chiefly of hornblende and plagioclase, together with a considerable quantity of epidote (much of which is doubtless primary), and biotite. The hornblende is the most abundant constituent, and occurs in irregular, cleavable, compact masses showing the usual trichroism. The biotite has undergone "bleaching" as the result of the removal of a considerable part of the iron, and as a consequence exhibits brilliant chromatic polarization between crossed nicols. It often occurs embedded in and sometimes completely surrounded by the hornblende. The felspar has undergone "saussuritization," and much of it, judging from the nature of the decomposition products, must be a plagioclase near the basic end of the series. Epidote is very thinly scattered through the slide, and besides being present as a product of alteration of the felspar, likewise occurs in tolerably sharp individuals enclosed in the hornblende. Quartz is only sparingly represented, as is also sphene. Apatite is abundant, while magnetite and pyrite are both present. The rock is a rather typical epidotic diorite, and may have resulted from the alteration of a gabbro.

Basic phase.

Intermediate phase.

'The slide representing the intermediate type of rock, differs from the preceding, in that biotite is the prevailing coloured constituent, and is associated with a large quantity of epidote, some of which is secondary, resulting from the alteration of the felspar, but a large pro-

portion is evidently original. A small amount of hornblende is present in addition to the mica, which latter mineral has undergone extreme bleaching and chloritization. Felspar is relatively more important, but it is difficult to say whether plagioclase or orthoclase prevails. Some of the iron ore at least is ilmenite, as it is partially decomposed to leucoxene. Pyrite is present often in well-formed cubes.

'In the section of the most acid type of rock which was the last to crystallize, the principal constituents are orthoclase, plagioclase, quartz, biotite and epidote, together with magnetite, sphene and zircon as accessory minerals, and epidote, zoisite and sericite as secondary products of decomposition, chiefly of the felspar. The bleached biotite is in places almost all gone to chlorite, and every stage in the process of alteration may be seen. The felspars are very much decomposed and filled with the usual saussuritic products. In the twinning of the plagioclase both albite and pericline laws are represented. The quartz is abundant in irregular areas showing beautiful undulatory extinction due to pressure. The rock is an extremely altered epidotic granitite. Acid

'The three slides examined represent magmatic differentiation in a very beautiful and perfect manner, the most basic form being a mica-diorite which has doubtless resulted from the alteration of a gabbro which contained biotite in addition to the original augite. The minerals in all three sections are essentially the same, differing only in their relative abundance.

'Most of the epidote, which is especially abundant in the most acid phase of the rock, but which is also plentiful in all the slides, is doubtless original, and the first of the coloured constituents to crystallize out, being embedded in the biotite, which is in turn enclosed in the hornblende. The large hand specimen shows in what is believed to be a very typical manner the method and order of crystallization resulting from the slow cooling of a deep-seated magma of heterogeneous composition.'

Behind the point where the spotted rock occurs, the gray granitite is cut by thin veins of black tourmaline.

The same gray granitite-gneiss forms the point in latitude 53° 12′ 30″, and foliation is everywhere apparent in a north-and-south direction, either as a linear arrangement of the mineral constituents or inclusions, or as a slight difference in colour and composition, and similar gneiss extends down the shore to Big Black River.

At the mouth of Big Black River the rock is a similar gray granitite-gneiss, cut by veins of fine-grained dark-reddish granite, and Rocks at Big Black River.

also by two narrow veins or dykes, a foot in width, of green felspathic actinolite-schist. These dykes have a general trend N. 25° W.

The same granitite-gneiss, usually without pegmatite veins, forms the shore of the bay for three miles and a half south-west from Black River. Near the point south of the bay the granite rock becomes a thinly foliated crushed granite with a regular strike N. 50° E. From this point southward to Poplar River the shore is fringed with many small rocky islands, which seem to be all of gray gneiss, in which granite veins become much more common as Poplar River is approached.

Rocks at Poplar River.

Near the Hudson's Bay Company's trading store at Poplar River, the rock consists of a greenish-gray epidotic granitite-gneiss, with, in places, a fairly well-defined foliation striking N. 35° W. This gneiss is usually rather fine-grained, but near the edge of the river it became very coarse-grained and much more massive. In this vicinity the gneiss is cut by several veins of soft, green, chloritic schist, which are probably highly altered forms of some eruptive rock. The rock is in many places covered by from two to four feet of a soft dark-blue clay, apparently without pebbles and probably deposited in the water. In it are numerous small concretions of calcareous matter. The rock is beautifully and apparently quite freshly striated, but this freshness is here due to the recent removal of the clay covering. The striæ run S. 40° W. but on one protected smooth surface they run S. 48° W. while at the same time a few shallow broken grooves probably made by the lake ice, run S. 15° W.

Glacial striæ.

Similar green granitite-gneiss forms the south shore of the bay for three miles west of the mouth of Poplar River, beyond which, to Poplar Point, the bay is literally filled with little islands of bare gray granitite.

Rocks at Poplar Point.

At Poplar Point the rock is generally a hornblende-granitite-gneiss well foliated in light and dark bands, with a regular strike N. 50° W., and a dip at a high angle S. 40° W. It includes a few irregular masses of dark mica-schist. It is also cut by a great number of both wide and narrow veins of red granite, the wide veins being fine, and the narrow ones coarse-grained.

The point itself is composed of a mass of high rounded knobs of granite, wooded with stunted Banksian pine, birch and poplar, while across a deep channel, two hundred yards wide, is an island with a precisely similar surface. Through this channel the York boats pass on their way up and down the lake. Just south of

the point is a considerable number of boulders and the rock is glaciated but the marks are mostly weathered out. However, a number of grooves are seen in places running S. 37° W. Some wooded islands lie north of the point, while scattered bare islands lie off shore for a couple of miles.

A prominent point, a mile and a half farther south, consists of contorted gneiss with dark- and light-gray bands intricately folded together; but a short distance back from the shore the strike becomes much more regular, trending N. 40° E. and dipping N. 50° W. at an angle of 30°. Points south of Poplar Point.

A point in latitude 52° 55′, in the bottom of the bay south of Poplar Point, is composed of beautifully foliated light- and dark-gray granitite-gneiss, having a general strike S. 60° W. and a dip N. 30° W. at angles of from 15° to 45°. It is cut by many veins of red granitite, a considerable number of which follow the lines of foliation. Beside one of the veins of red granitite was a vein of dark-gray hornblende-granitite. The surface is rounded but the striæ are generally weathered out. They are, however, seen running S. 25° W. The shore to here has been generally low and sandy with a few weathered bosses of similar gneiss, both on the beach and a short distance out in the lake. The land behind is all low and apparently a cranberry marsh. In the distance is a spruce forest. A little turf was seen in one place but no clay.

Similar granitite-gneiss outcrops in numerous exposures along the shore to about two miles south of Marchand Point, south of which, for nine miles, the shore is an even sandy or stony beach, without any outcrops of the underlying rock.

At Marchand Point the land behind is all low with a high ridge of sand behind the beach. The south-western side is surrounded by a closely packed boulder-pavement of rounded boulders, chiefly gray granite, this being the most boulder point northerly on this side of the lake. The land on the point is about eight feet above the lake. Just to the south of the point is an island composed entirely of boulders. The low land stretches south to past Big Stone Point, and that point is only a small promontory of Archæan boulders with no bed-rock in sight and is thickly covered with driftwood derived from the wear of the face of the swamp to the north. The boulders are composed of gray and greenish, massive gneiss with some of red granite and a few of lamellar schist. One, eighteen inches in diameter, of greenstone conglomerate was observed, but two of the Marchand Point. Boulders point.

largest from fifteen to twenty feet long are composed of reddish-gray massive gneiss cut by veins of coarse red granite. They are about eight feet high and one is broken.

In latitude 52° 43′ three or four smooth rocky bosses rise about two feet above the water, consisting of dark-red granite-gneiss with a slight foliation N. 65° E., cut by thick veins of a lighter red, coarse- and fine-grained pegmatite.

Mossy Point. Low reefs of reddish-gray granite-gneiss lie off the point in latitude 52° 38′, one of them containing many elongated inclusions of dark-gray hornblende-schist. Thence southward for two miles several small outcrops of similar gneiss occur, after which, for several miles past the mouth of Leaf River, the beach is composed entirely of sand and boulders, but to the point of Sandy Bar, low rocky reefs, apparently of gneiss, lie here and there off the shore.

South of Sandy Bar some rather high bare rocky islands, composed of massive reddish-gray granitite, extend inwards towards Berens River.

Mouth of Berens River. Near the trading store of the Hudson's Bay Company, on Berens River, the rock is a reddish-gray granitite-gneiss in thin and very much contorted bands. At the point, a dyke of dark-gray, highly altered eruptive rock, cuts the gneiss, and strikes in a general way parallel to the river, appearing on several of the points in the vicinity. On the south side, the gneiss is very much contorted, but apparently with a general strike N. 60° E. It is also cut by a vertical dyke, two feet wide, of hard, green gabbro-diorite running N. 45° W.

Along the south side of Berens Bay, the first large island is composed of dark-gray, well foliated gneiss, varying in the different bands from a granitite to a hornblende-schist. It is usually fine-grained, but large felspar crystals are drawn out along the lines of foliation. It appears to have a general dip N. 50° E. $<$ 45, though in detail it is very much contorted.

Flathead Point. Flathead Point is composed of a light-gray granitite-gneiss striking N. 40° W., and with an approximately vertical dip, cut by many veins of red pegmatite.

Pigeon Bay. The northern and eastern shores of Pigeon Bay are for the most part low and sandy, with occasional low outcrops of similar granitite-gneiss, often riddled with pegmatite veins.

The south shore of the bay is much bolder and more rocky, being composed of a coarse-grained, greenish-gray granitite, usually massive,

and containing a few inclusions of a darker gneiss. But few pegmatite veins are seen. Just east of Pigeon Point the granitite is cut by an irregular, disjointed dyke of dark-gray diorite. At Pigeon Point the granitite, while usually massive, occasionally shows a well-marked foliation striking N. 50° E. Pigeon Point.

For four miles south of Pigeon Point, the shore is low and sandy, and from beneath the sand, peep out many little low exposures of massive, dark-gray mica-diorite, often cut by large veins or masses of gray, red-weathering compact granitite. The diorite extends a short distance farther south and then, at Catfish Point, is replaced by a gray, well-foliated, granitite-gneiss striking east and with vertical dip.

Half a mile south of Catfish Point, the foliation of the gneiss strikes N. 45° to 75° W. The gneiss includes many elongated masses of dark-gray schist, the foliation running around these inclusions, often giving the rock a very irregular brecciated appearance. A mile farther south the gneiss contains many inclusions of dark-gray diorite-schist, some of which are altered to chlorite-schist. Similar rock continues along the shore to Catfish River. Near Catfish Point.

Seven hundred and fifty paces south of Catfish River, the point is composed of coarse-grained hornblende-granite, traversed by irregular veins running into larger masses, of a redder finer grained granite. Two hundred and sixty paces farther south, a reddish hornblende-granitite is in sharp contact with a darker hornblende-granitite, both being usually massive, but showing traces of foliation in some places. On the beach, six hundred paces farther, a gray coarse-grained granitite-gneiss is exposed and extends three hundred paces farther where it is distinctly foliated N. 50° E., with a vertical dip. South of Catfish River.

Half a mile south, in latitude 52° 7′, the rock is an intimate mixture of rather fine-grained granite or granitite, and coarser diorite, cut by veins of red pegmatite. At the point half a mile still farther, the rock is light-gray hornblende-granitite, with very few inclusions, and occasionally showing an obscure foliation S. 85° E.

Similar gray hornblende-granitite outcrops here and there along the shore of the bay to Flour Point.

Many low rocky reefs lie off Flour Point, and they, with the point itself, consist of coarse red granitite, with many large porphyritic crystals of orthoclase. Through it are running two straight veins or inclusions, one to two feet wide, of dark-gray granitite-gneiss. In other places there are many inclusions of dark-gray fine-grained granite, almost always cut by pegmatite veins, thus giving it very much the appearance of the 'leopard rock' (p. 26G). Flour Point.

South of Flour Point.

Three-quarters of a mile south, is a point composed of dark greenish-gray, massive, coarse quartz-augite-diorite, cut by wide and narrow veins of red pegmatite. This dark basic rock is again succeeded by massive red granitite similar to that at Flour Point.

For three miles farther, south-east along the shore, there are occasional outcrops of similar red and gray granitite. In latitude 52° 2′, the rock is a very acid, red granitite-gneiss, distinctly foliated N. 50° E. Three-quarters of a mile south-east, is a point composed of a dark bluish-gray, light-weathering hornblende-granitite, without foliation, but cut by a few veins and lenticular patches of red pegmatite.

Seven hundred paces farther south-east, the rock is an evenly foliated quartz-mica-diorite, very much cut and broken by granite veins. One of these, two feet in width, is a dark-gray porphyritic hornblende-granitite, similar to the rock at the last point.

At Split-rock Creek.

At the mouth of Split-rock Creek, and along the shore for half a mile to the north and three-quarters of a mile to the south, the rock is composed of a very red massive granitite, in some places very compact, and in others, cut by veins or masses of dark porphyritic hornblende-granitite ; these are again cut by smaller veins of red pegmatite.

South of the mouth of a brook, in latitude 52° 0′ 30″, the shore becomes much bolder, being composed of a reddish granitite-gneiss, with a dip north at an angle of 55°. In a few places this gneiss is interlaminated with a dark-gray hornblende-schist. The rock preserves this character for half a mile along the shore, and then again becomes more massive and less distinctly foliated.

South of Split-rock Creek.

On the south side of the little bay, the rock is again a coarse, red and dark-gray granitite without any signs of foliation. At the point south of the bay, and for half a mile or more to the south of it, bands of dark-gray and light-red granitite together form the shore, being separated by sharp lines, which run S. 85° E. The rocks are usually massive, but near the junction the red granitite is foliated parallel to the line of contact. Farther south the two become intimately mixed together, though the gray predominates, and gradually becomes foliated in the above direction.

The point in latitude 51° 58′ is a reddish granitite-gneiss, of uniform grain, and with a somewhat indistinct foliation striking westward. It is cut by one wide pegmatite vein along the line of strike but by very few smaller veins.

In latitude 51° 57′ the rock is a rather dark reddish-gray granitite. No foliation is apparent, but on the south side of the point a some-

what redder granitite abuts against the last. Both are of about the same texture, and the difference in composition of the two is probably slight. A similar massive reddish-gray granitite forms the next point to the south.

On the north side of Rabbit Point, the rock is a similar massive, dark-gray, granitite, without inclusions, but cut by a few veins of coarse, red pegmatite, from two to ten inches in width. These are composed chiefly of clear quartz, and salmon-coloured orthoclase, but some large crystals of biotite are also present, and one vein contained some crystalline masses of purple copper ore. Similar, coarse red granitite extends around Rabbit Point, and along the south shore of Bloodvein Bay to the long point in latitude 51° 50′, east of which the shore is low and swampy. The rock is usually quite massive, but is often cut by vertical and horizontal jointage planes, and thus forms a steep and bold shore. At the last-named point the rock becomes distinctly banded in lighter and darker bands, with a strike N. 25° E. Rabbit Point.

The islands and the south shore of the bay are also composed of similar coarse red granitite, which is either massive, or has a slight foliation, distinguishable on weathered surfaces by the more or less evident linear arrangement of the constituent minerals.

Belanger or Little Black River.

The river up to the first rapid, a distance of nine miles, is without noticeable current, and varies in width from sixty to one hundred yards. The banks are clay, from six to fifteen feet high, wooded with white poplar and black spruce. Very few outcrops of rock are to be seen, but at the fall, which is of eight feet, there is a ledge of medium-grained, gray granitite, cut by veins of red pegmatite. Above this the stream is narrower, being only from thirty to fifty yards wide, with banks usually overhung with willows. The water is both dark-coloured and muddy. From this portage the clay-banks continue to rise gradually until at the next portage they are eighteen feet above the water, and the surrounding country is an apparently level plain. Below the portage the forest is green, but above, it has been burnt over, apparently some time ago. The rock outcropping at the portage, which is ten miles east from the mouth of the river, is a massive, gray quartz-mica-diorite precisely similar to that seen on the south branch of Gunisao River. Outcrops of this gray diorite occur here and there along the river banks, and at the next portage, three miles above the last, it is cut by a dyke of dark-green hornblende-schist, one foot in Belanger River.

width, striking S. 15° W. The next two rapids are also caused by similar dykes cutting across the diorite, which has become distinctly foliated, striking with the general course of the stream.

Massive rocks. Near the mouth of the south branch of this stream, massive reddish-gray granitite appears for a short distance, and the massive quartz-mica-diorite re-appears on the upper reaches of the stream. The country through which this stream runs appears to be very generally covered by a thick deposit of clay and is well wooded. Isolated hills appear on the south side below the north branch, and these are of rock protruding through the clay plain. For the rest of the distance up the north branch, as far as explored, the quartz-mica-diorite is everywhere the prevailing rock, usually massive, but occasionally with a slight foliation or linear arrangement of the crystalline constituents. In places it becomes somewhat more acidic and should perhaps be more properly grouped with the granites. The small stream followed above the forks becomes very narrow and branches again. The channel is narrow and often very much obstructed by boulders, with many impassable rapids around which it is necessary to portage. The banks are rocky, overlain by silty clay, and the general character of the country is a moderately even plain with little rounded rocky knolls rising a few feet above the surface. Green timber is again seen in the upper reaches of the stream, but it appears to be of little value.

Big Black River.

Big Black River. The late A. S. Cochrane in the summer of 1882 surveyed as much of this and Poplar River as is shown in full lines on the accompanying map. In his note books the rock almost everywhere is said to be a 'dark-gray massive gneiss' probably a quartz-mica-diorite or a basic granitite. His notes give the following general description :— 'For a mile above the first portage the rock is all a coarse, gray gneiss. Since passing the mouth of Rice Lake branch, most of the points at bends of the river and all at the rapids, are of gneiss which has a greenish tinge on new fractures. All along the river the soil is excellent, being a light-gray friable clay, which should produce much better timber than it generally does. The timber is all well mixed, with about equal proportions of Banksian pine, spruce, balsam, tamarack and poplar, and a small quantity of birch. No really good timber was seen till the foot of Island portage was reached, where, on the right bank of the river, there is a small grove of perhaps twenty-five trees of spruce varying

Timber.

from nine to twenty inches at the base. From that point quite a number of fine trees were passed that would average fifteen inches. On one point of the river, about half a mile above the Mink portage is a grove of about twenty-five spruce trees averaging twenty inches in diameter. The water of the river is not only of a dark colour but also very muddy. This river is evidently very little used as a summer route, the portages being poorly marked and the bush, so far, unburnt. The best timber in the valley is up the three small rivers which empty near the lake.

'Above the Long Rapid some very fine sticks of spruce were noticed, one fully thirty inches in diameter. The land up to the Pelican portage is first-class, but above this there is a low and swampy country which extends to the "Rapids-close-together." A border of good land on which some fair sized timber grows runs along both sides of the river. The rock showing along this strip is all of a dark, or light-gray, massive gneiss. In one place only was it stratified, and even there it was difficult to distinguish the strike and dip. The Pelican River, though but a small stream, extends a long distance, coming from a little north of east. For the last ten miles before reaching the small lake, the river becomes somewhat wider and for the most part is lined with a border of reeds and rushes with a few stalks of rice. This lake, one of two through which the river passes, is a small one with a few islands. It is bordered nearly altogether by green wood which is here all Banksian pine averaging from four to six inches in diameter The water is very dark and of a reddish tinge. The shores as far as seen are all of rock and small boulders of gneiss. No hills can be seen on either side. From here to the portage across to a branch of Poplar River, the stream is very crooked and its banks are thickly bordered with gray willow. They are very low and in years of even ordinarily high water they must be nearly submerged.

Good land below Pelican portage.

'The stream is here very shallow and in many places it is difficult to pass; especially is this the case at the sites of the old beaver dams, of which there are many.

'The country appears to be all swampy, for some distance at all events from the river. All the rock is dark- and light-gray massive gneiss.

'The portage from this branch to a branch of Poplar River, is divided about midway into two sections by a small lake. The first portage is 3,880 paces long, and although it crosses several narrow ridges of rock, most of it is through level muskeg, very much more than knee-deep in most places. The lake is called Watchee, or Greeting

Portage to Poplar River.

Lake. The southern portion of the trail is by far the worst, as it is through a soft swamp, without any supporting moss.'

The rocks noted on the river are: at the first portage, gneiss, striking S. 60° W.; at Wolverine portage, coarse dark-gray gneiss, striking N. 30° E., and at rapids six miles above Pelican River, coarse, dark-gray gneiss striking N. 30° E., dipping S. 30° E. < 25°.

Poplar River.

Poplar River. From the portage, at the head of the north branch, downward, very little rock is seen, an exposure of dark-gray massive gneiss occurring six miles below the portage. The soil as seen along the river banks, which are about five feet high, is good, but it seems to form only a narrow border along the stream. Before joining the main stream the branch passes through a rougher, more rocky strip, and several falls and rapids occur. The timber on the upper part is heavier than down near the river, partly owing to better soil, but mainly to the absence of forest fires, the country near the river having been burnt over repeatedly. The first rock exposure below the north branch, is not of such a massive type as that up the branch; the strike is S. 10° E., dip N. 80° E. < 40°.

Soil and timber.

Thunder Lake. On an island in Thunder Lake, the rock is a very coarse, light- and dark-gray and brownish-gray hornblende-gneiss, striking east with a dip south < 20°. For fourteen miles farther down the river, there seems to be no marked change in the rock, which is probably all gneissic, with so little change in the strike that it has been noted in but few places. Contorted dark- and light-gray hornblendic and micaceous gneisses striking E., dipping N. < 55°, occur a mile farther down, and at the White Mud portage, ten miles above the Indian reserve is a very coarse, dark- and brownish-gray garnetiferous gneiss, striking N. 55° W., dipping N. 35° E. < 50°. The rock at the rapids two miles above the reserve, is a dark-gray gneiss containing mica and some small quartz grains, striking N. 65° W., dipping N. 35° E. < 50°.

Berens and Etomami Rivers.

Berens River. At the mouth of Berens River the rock is a reddish-gray thinly foliated granitite-gneiss, and near Mr. McKay's house a gray contorted gneiss projects here and there in little rounded bosses, but apparently with a general strike S. 60° W. It is also cut by a vertical band of hard, green gabbro-diorite two feet wide, with clear cut walls, striking N.W. The rock is well striated, except in places that have been exposed for a

considerable time, and is covered with a dark-gray clay without pebbles. Along the contact line with the rock a boulder is, however, occasionally seen. This clay, like most of that seen on this shore, appears to have been deposited in water.

Similar granitite, sometimes massive and sometimes foliated, extends up the river to the mouth of the Etomami River and was found to underlie the country along that river throughout its whole length, to where it joins the Berens River at the Pot-hole portage. Mr. A. S. Cochrane in 1882 and Mr. A. P. Low in 1886* also found the country along the Berens River to be underlain by similar rocks between the same points.

Pot-hole portage.

At Pot-hole portage, just to the west of Long Lake, the portage road is across a low point of smooth rock. From a bay twenty yards wide, on the opposite side, a rocky point fourteen feet high projects north-eastward into the river descending more or less abruptly into deep water. On the south-west side of this hill and between thirty and forty yards from its point are several beautiful pot-holes. The uppermost one, with a rim ten feet above the water of the river, is filled with water and has only been cleaned out to a depth of about two feet. Three feet south-west of this one, are four others which have all cut into each other. The highest point on the rim of these is nine feet above the water, and the bottom of one is at least a foot below the water. The outer half of this one is cut away almost vertically and the face of the cut cliff is strongly scored by glacial grooves. Another one four feet farther south-west has the top of its rim, eight feet above the water, and descends to at least two feet below it. The diameter of this one is thirty-three inches and is almost perfectly circular at the top. It is quite vertical and unbroken, varying but little in width as it descends. Its rim is thus five feet and a half above the surface of Long Lake. Mr. Angus McKay, who cleaned it out, says that it was filled with rounded gravel and cobble-stones up to the size of a man's head. Several bushels of these are now lying about, mostly gray granite, but some are of greenstone. The rim is just on the edge of the steep rocky cliff descending to the water. Six feet south-west of it, is a well-marked, deep, smooth groove cut down the face of the little cliff, and at the foot, on a low terrace, are two other holes that have not been cleaned out. Near the deep holes, both above and below, are several small shallow holes also rounded out by pebbles and boulders.

Pot-holes

Glaciation.

The glacial grooves run generally S. 63° W. and the pot-holes are clearly older than this glaciation, for some of their rims show distinct

* Annual Report, Geol. Surv. Can., vol. II (N.S.), 1886, p. 17 F.

glacial markings on the southern side, while the opposite side is broken. The fracture that cuts one pot-hole almost vertically, is strongly marked by glacial groovings. They would appear to represent the position of a fall in a river flowing southward or south-westward in early glacial or pre-glacial times, the water tumbling over the ridge that here runs east for a short distance. Now, the ridge is cut away at most places, leaving this an almost isolated hill with lower land apparently all around it and certainly much lower to the north-east in the channel of the river. The rock here is a coarse, dark-gray massive, quartz-mica-diorite, containing some large irregular inclusions of dark-gray hornblende-schist. The diorite, is irregularly fractured and jointed and it weathers with a very much pitted surface.

Painted-moose portage.

Painted-moose portage, at the east end of Long Lake, is over a massive red granitite, cut by a dyke, about thirty feet wide, of coarse dark-green diabase, very much crushed and altered. The walls of the dyke are not well defined, but it has a general strike about east-and-west.

Manitou portage.

Three miles higher up stream, the rock is a dark-gray diorite, cut by or associated with a mass of red granite. This diorite, outcrops at several places along the banks up to Manitou portage where the river flows between high, rounded rocks, of a massive, irregularly jointed, dark-gray quartz-diorite. The rock crossed by the portage is composed of a fine-grained groundmass of quartz, felspar, hornblende, biotite, etc., in which are embedded large phenocrysts of plagioclase and quartz. It might thus be styled a quartz-diorite-porphyrite. Its relationships to the surrounding rocks were not determined.

Above this rapid to the Hudson's Bay Company's trading post at Grand Rapids, the rock is chiefly a red and gray granitite.

Crane portage.

Crane portage is on the south side, over level clay, through poplar woods. The clay is a soft light-gray, without pebbles or boulders, and this is the highest point on the river at which it was observed.

Night Owl portage.

Night Owl portage is through poplar woods over a rocky ridge. On the upper side of the ridge is sand with pebbles. On the lower side is a long slope of gray sand, apparently without pebbles. The total descent is almost forty feet. Boulders are plentiful above this to the Grand Rapids and the country is wooded with green poplar.

Etomami River.

The Etomami River though a branch of Berens River, forms another channel in high-water, being connected at its upper end by a small creek which at low-water drains from a small lake to the Berens River below the Pot-hole portage. This creek is about forty feet wide up to

the lake, but it is almost choked up with wild rice and even on the lake, spears of it are seen here and there. Above the lake it gradually narrows until it barely permits the passage of a canoe, and then widens somewhat. It flows through a wide marsh between rocky hills and ridges wooded with tall Banksian pine, rising abruptly from the edge of the marsh. There is no sign of clay, but the whole country is rock and marsh and occasionally a tamarack swamp. The rock is a massive, gray gneiss, apparently similar to much that is seen in the Berens River valley. The first fall on the Etomami River, below the little lake at its head is about eight feet, but so little water is running that there is no fall in summer. The beavers have added to the natural barrier a little, in order to make the pond above useful to them.

For a couple of miles down, the river flows between steep, though not high, rocky hills of massive, gray granite, wooded with small Banksian pine, and below that, to near the Boulder Rapids, it winds between low-lying rocks in a spruce and tamarack swamp, with a weedy channel 60 to 100 feet wide. The only trace of later deposits over the rock, consists of light-gray fine-grained silt with pebbles, but this is very scanty. At the Boulder Rapids, which is a descent of fifteen feet in the river over boulders, the first stratified lacustrine deposits of the Lake Agassiz basin on this branch are met with. In a bay in the rocks on the north side is a large and well-defined terrace of coarse, reddish-gray sand, while just up the river in the gray silty till, are many well-rounded pebbles. The surrounding rocky hills are twenty to forty feet higher than this terrace. For a short distance below, the river flows in the bottom of a straight valley 200 to 400 feet wide and forty to eighty feet deep, with bold, steep granite sides. The channel is forty to sixty feet wide, with a bed of boulders, but is now almost choked with a thick growth of equisetum. It soon widens out, however, with low, sandy banks, wooded with tall, white poplar and Banksian pine, and farther down the whole country seems to a certain extent to be nearly a level plain of sand or clay, with rocky knolls and ridges projecting here and there.

Boulder Rapids

Within ten miles of the mouth the banks gradually become better wooded with tall, white poplar, and Banksian pine in the more rocky places. A few stunted oak and maple trees also appear. Little or no spruce is seen near the river above this point, but a few trees appear. The river maintains an average width in the lower portion of over fifty feet, except at the rapids and a few narrows, but there is no current and very little water is flowing. The water is clear but exceedingly dark in colour. The banks are generally of clay, sloping westward,

River near its mouth.

with the slope of the country. The clay near the mouth is soft and blue, but farther up becomes gray and silty. The estimated fall for the river from Pot-hole portage on the Berens River to the mouth is over 180 feet,—it may probably be as much as 200 feet.

Pigeon River.

Pigeon River.

On this river, from its mouth up to its head in Family Lake, the country is entirely underlain by granitite and granitite-gneiss, massive or more or less distinctly foliated, and varying slightly in different places from acid to basic varieties.

At the first rapid, four miles and a half up the river, the rock is a mixed gray and reddish-gray, well foliated granitite-gneiss, striking S. 65° E., and with vertical dip. At the next rapid, between three and four miles farther up, it is a coarse-grained, gray, porphyritic hornblende-granitite-gneiss, with a well-marked structure striking eastward. Similar gneiss occurs at Sturgeon Falls, where it contains many darker lenticular inclusions, and has a general strike S. 65° E. Granitite-gneiss occurs all the way up the river, occasionally cut by granite veins, or containing darker inclusions, but varying so little in character that it is unnecessary to enumerate details for each separate locality, especially as the strike of the rock is shown on the accompanying map.

Sturgeon Falls.

The general character of the country passed through is, however, added from the notes taken on the trip up.

From the mouth up to Sturgeon Falls, the river has wooded banks of clay but above this point to near the next fall, the stream winds with slight current, through low land with marsh occasionally on the edge of the river. The clay banks, however, gradually rise until they have attained a height of eleven feet at a point seven miles in direct line east of Sturgeon Falls. The rock crops out all along the bank, and the general thickness of the clay deposit is very much less than on the streams farther north.

Poplar Falls.

All the surface deposits recognized up to Poplar Falls are of clay, but there the banks are composed, from the water up, of a thickness of eight feet of horizontally stratified, fine, almost white sand, separated here and there by thin layers of white clay. The surface is unevenly eroded and is covered by two feet of clay and sandy soil, probably fluvatile. A short distance above, at a fall of nine feet, a great number of boulders are scattered on the beach at the foot of the fall. These are chiefly of gray gneiss and granite, but some of the smaller ones are

of massive greenstone. The banks are apparently of clay and have here risen to twelve feet above the water. The next rapid has a drop of four feet, past which is a portage of twenty yards over an island. The centre of the island is a level clay plain, nine feet above the water at the head of the portage. A number of boulders are embedded in the bottom of the clay, especially on the south side of the island. A third of a mile above the island portage, the river rushes through a narrow gorge in low hills of gneiss. At the south end of the rapid the clay rises in a terrace twelve feet above the water, but it is apparently well filled with pebbles and boulders ; glacial grooves run S. 65° W., but on the south side on protected surfaces, a set trending S. 35° W. may be occasionly seen, probably only an earlier stage of the same glaciation.

On the west side of this rapid there is a portage-road one hundred and twenty yards long over the rock along the edge of the river.

Round Lake.

The little lake through which the river passes a few miles above these rapids is called Round Lake and has rocky shores with occasional sandy beaches, and at the east side is a terrace of clay, six feet above the water.

Jack River portage.

At the Jack River portage, just east of the lake, the road is over a hill or bench of gray clay which is twelve feet above the water at the head of the rapid, and it is seen to be sandy with rounded and angular pebbles and some boulders. Three miles above, after passing two or three small rapids, the clay banks rise to ten feet above the water, but the general appearance of the country is an almost bare, rocky plateau, thirty to forty feet above the water. A fall divided by an island is next met, and with one above give a total descent of fourteen feet, equal to the depth of clay deposit below. The surrounding country has been burnt, and the smoothly rounded hills are streaked with a young growth of small Banksian pine, while over them the bleached trunks of the old trees are often still standing. The ascent of the upper part of the river is difficult, the current being often strong with many little rapids, and the steep rocks necessitate long portages often past very short rapids. Most of the portages are blocked by fallen timber. The clay does not appear to be a river deposit, but rather a thin coating of clay lying between the rocky knolls and sloping with the country. From here up to Goose Lake the river flows generally in a narrow valley, along the strike of the gneiss, and the whole country is rocky and barren. The current for the most part is strong and the fall from Goose Lake to below Long portage is estimated at about eighty-five feet. No timber of any value is to be seen on this part of the river. In the vicinity of Goose Lake the

Goose Lake.

country is almost all rock, but has not been burnt over and is wooded with tall, thin spruce and Banksian pine of no particular value. Above the last lake, there is a thin deposit of clay, perhaps two feet, in the hollows between the rocks.

The portages above Little Goose Lake are generally over rock, but along the north bank, at the middle one, is seen a scarped bank of twenty feet of sand, pebbles and boulders, doubtless on the lee side of a rocky hill. Boulders are scattered plentifully along the bank. Most of them are of the character of the surrounding rock, but a few are of white, rather fine-grained granite.

Shining Fall. At the Shining Fall or Little Grand Rapid the portage is 300 yards long, on the south side, over a plain of light-gray, clayey sand with pebbles, rising to the level of the top of the rapid and wooded with small spruce and poplar. The fall is a beautiful cascade with a drop of twenty feet, over a ledge of massive, gray gneiss, having a slight foliation S. 50° E.

Family Lake. Family Lake, which drains by this stream as well as by the Berens River, extends very far to the south of the arm from which the Berens River issues. The shores of this part are generally rather high and rocky. Those facing the east being smooth and scored or rounded by the glaciation, while those on the opposite side are broken and often the rock is hidden by a considerable thickness of sand and boulders. The timber is small Banksian pine and spruce with some birch and poplar.

Miskowow or Bloodvein River.

Miskowow River. Near the mouth the rocks are very bare, but a mile or so up, the river has banks composed of clay about five feet high, wooded with poplar, some oak, &c., with low, rounded bosses of vertically jointed rock at the points. The stream averages from forty to fifty yards wide, with water of a brownish tinge, but not dark, like that in many of the streams on this side of the lake. The banks are never very high, but they are usually rocky and often the river would appear to flow in a pre-existing rocky channel. Between the rock exposures the blue clay that is seen everywhere in the lower land east of Lake Winnipeg, forms well-defined banks, wooded with poplar, while on the rocky parts is a scanty growth of Banksian pine. Oak grows here and there on some of the dryer points.

Pot holes. About nine miles from the mouth of the river a portage of 140 yards is made past a rapid and on the summit of this portage, at the very top

of the rock, fifteen feet above the water at the head of the rapid, is a beautifully rounded pot-hole eighteen inches in diameter and eighteen inches deep. A foot lower down the slope and ten feet south-east, are two similar holes, partially broken into one, respectively two and three feet deep. Six feet lower down on the southern slope are two more small ones. The rims of the upper ones are very perfect, but still they appear to be a little broken on their north-east and rounded on their south-western sides, indicating an age at all events previous to the last glaciation, perhaps interglacial.

When formed.

The little Bloodvein River comes in at the north corner of a sharp bend above this and the river again makes another abrupt turn to the south-west. At this angle, which is a short distance below Birch portage, the river turns suddenly down through a narrow rocky gap, and a pot-hole was here observed on the south-east side of a steep rocky hill. It is quite round and has a diameter of thirty-four inches. Its top is ten feet below the top of the rock, and its rim is cut away obliquely so that the south-east side is two feet lower. Below this it has a depth of two feet. This lower part of the rim is now three feet above the present level of the river, but several feet below high-water level. The surface of the rock, sloping at an angle of 45°, is strongly glaciated.

Near Turtle River.

From the Pot-hole portage up to the mouth of Turtle River the banks are generally rocky and there are many rapids, several having very picturesque falls. About half way in this distance the river divides and flows round an island half a mile long. On the north branch a portage of two hundred and twenty-five paces long is made past a fall of eleven feet. At the west end the road rises thirteen feet to the top of a little terrace of moderately well rounded gravel and the portage follows on a clay and boulder plain in a narrow gap between the rocks, falling, at the east end, two feet to a marsh.

Terraces.

About two miles east of this, the terrace rises to twenty feet above the river and is of light-gray clay, but at the next portage a short distance farther, the surface is at thirteen feet, while above is a bank of nine feet. The bottom of this bank appears to be of bluish clay but the top is sand mixed with gravel, and on the surface it is a sandy plain lying between two ridges of rock.

Eastern limit of lacustrine deposits.

The river here flows through a very rocky country that has been burnt over some years ago, and there is in this vicinity very little land of any value along its banks. This appers to be near the eastern limit of the Lake Agassiz clay.

In the vicinity of the forks the surface is a plain ten feet above the river, formed by a gray, silty clay with occasional angular pebbles and boulders.

North branch.

The main branch of the river from the south-east enters a lake-like expansion, an irregular basin, surrounded by steep, though not high, rocky hills, thinly wooded with Banksian pine, small poplar and birch. In the depressions and on the lee sides of the rock is a thin coating of a rather loose, gray till containing a great many angular pebbles.

The north branch comes from Sasa-ginnigak Lake, but a short distance up it is divided into two branches, one coming from a narrow bay leading to the north end of the lake, the other by a shorter channel, from the south-west corner of the same lake. This to which the Indian name is given (instead of Island Lake) has rather high shores of granite, thinly wooded with Banksian pine and poplar. In it are many rather high islands which often stand close together. The water is moderately clear and without weeds.

General character of rocks.

The underlying rock on the river, as far as it was examined, namely up to Sasa-ginnigak Lake, is everywhere a red, gray or greenish-gray granitite, either massive or foliated, the foliation often more or less nearly approaching the horizontal.

At the first portage, a mile above the mouth of Osapiniwin Creek, it is a medium-grained, reddish-gray, granitite rich in plagioclase, with occasional gneissic foliation. From there upward for several miles, the foliation is all more or less nearly horizontal.

At a portage, 140 yards long, where there are a number of pot-holes, the rock is a greenish-gray, basic granitite or quartz mica-diorite. From this point upwards to Kinawi or Golden Eagle Rapid, a reddish-gray granitite is the prevalent rock, with a slight, nearly horizontal foliation, though at this place the foliation dips northward at an angle of 25°. From this rapid up to the forks, the rock, usually a gray granitite, is for the most part massive, and when foliation is to be detected, it is very indistinct. There is also a marked absence of pegmatite veins throughout the rock.

Kinawi Rapid.

Similar granitite occurs up the main branch of Miskowow River to Kowtunigan Lake, above which this river was not examined. On the north branch, flowing from Sasa-ginnigak Lake, the rock at the falls above the mouth of Sturgeon Creek is an irregularly banded, red and gray gneiss, with vertical dip and east-and-west strike, having the general appearance of a mica-schist interfoliated with thin bands of granite.

Sasa-ginnigak Lake.

On Sasa-ginnigak Lake, and on the two branches of the river below it, the rock is also a medium-grained gray granite, usually massive, but, occasionally foliated.

Shore of Lake Winnipeg—Dog Head to Loon Strait.

This strip of shore is very regular in outline and closely follows the direction of the strike of the gneisses. From the evidence of the exposures on the points and in Loon Bay, it is supposed that the channel, occupied in this part by the lake, is croded along the line of a band of dark schist and greenstone which might possibly be of Huronian age, though much altered by contact with eruptive granite or gneiss—a band of which outcrops at Loon Strait. It is also supposed to continue, in a highly altered state much reduced in thickness, as far as the vicinity of Rice River where dark-green porphyry associated with porphyritic gneiss, and dark fine-grained schists outcrop above the first rapid. General character.

The larger islands off the point opposite Dog Head, are composed of a well foliated porphyritic granitite-gneiss, containing large porphyritic crystals of felspar, around which the groundmass exhibits a well marked flow-structure. The foliation is straight and regular in a direction N. 60° W., with a vertical dip. This evenly foliated gneiss gradually changes into the much less distinctly foliated gneiss seen on the shore to the east, no sharp line of demarcation between the two being evident. East shore opposite Dog Head.

On the point south-east of these islands the rock is changed to a coarse, porphyritic hornblende-granitite-gneiss, while at a point near the bottom of the bay south of this, there is a band thirty feet wide of a fine-grained reddish, porphyritic granitite-gneiss, behind which is a coarser banded, green and red hornblende-granitite-gneiss dipping north-eastward at an angle of 70°.

The next point down the shore, almost directly opposite Dog Head, is composed chiefly of porphyritic gneiss, in which are some darker and finer bands, as well as bands of fine red granite, all striking, as before, along the shore.

The next point, half a mile farther south, shows fifteen feet of an evenly laminated reddish felspathic granitite-gneiss, dipping N. 35° E. < 75°, cut by minute joints which cause it to break readily into small angular fragments, and weathering with a very red and much-pitted surface. Behind this, for 450 feet is a thickly laminated dark-gray hornblende-granitite-gneiss, weathering to a light rusty brown, and also breaking along numerous jointage planes. Succeeding this is a coarse porphyritic gneiss.

In latitude 51° 43′ 30″, the rocks were examined for a mile and a quarter back from the lake, and were found to gradually lose their

strongly laminated character, until, at the end of the above distance, the foliation was marked by a slight linear arrangement only of the crystalline constituents.

About four miles south from Dog Head this shore is composed of a gray, foliated gneiss, striking N. 60° W. with an almost vertical dip. Some of the bands are dark and moderately fine-grained with veins or bands of fine, red granite, striking in the same direction, lying along the plane of foliation. The composition of the gneiss which might be termed hornblende-granitite-gneiss, is found to remain very uniform for some distance, but gradually loses its crystalline appearance, becoming, farther south, more micaceous, and in places is in part a mica-schist. The foliation throughout is very even and regular with few contortions.

Opposite Limestone Cave Point.

Abreast of Limestone Cave Point, the shore-line crosses the strike for a short distance to the west. Opposite some small islands lying near the east shore, the rock is a reddish-gray, thinly foliated gneiss, but the foliation is not so regular as before, and many of the bands anastamose with each other, so that it is difficult to determine the exact strike. It is, however, nearly parallel to the general trend of the shore-line.

Surface deposits.

The rock is overlain by a foot or two of coarse, angular sand containing pebbles and boulders, few or none of which show any sign of glaciation, though the rock is smoothed and grooved. This sand is in turn overlain by a soft blue clay without pebbles, the same as noted before. On the surface are some pebbles and boulders. The whole shore is here piled up often to a height of ten or twelve feet, with large, rounded and angular boulders, many of which are of massive gray gneiss. To the south the shore for a short distance is sheltered by long narrow islands, and boulders are not so plentiful. Passing these, the shore becomes high and rocky, cut by deep, narrow inlets. The rock is of similar character, with a strike parallel to the shore. Little cliffs of clay and boulders are seen farther on, overlying the rock and the shore is strewn with boulders chiefly of gray massive granitite-gneiss. These little boulder hills extend along the shore for a considerable distance and appear to be morainic. The islands mentioned above are mainly rocky, though covered by spruce and scrub pine. The rock is a rather fine-grained regularly-foliated granitite-gneiss, with a few veins of red pegmatite running generally with the foliation, but at times crossing it obliquely. On the mainland a little to the south, the gneisses are tinged with a light-green colour, becoming deeper across the strike to the east. At about one

hundred yards east, bands of green chlorite-schist appear, interbedded with the granitite-gneiss, while farther on there is a dyke or band of green chlorite-schist with a width of nearly five feet. In it are seen large included crystals of orthoclase. This band is parallel to the foliation, but in one place it appeared to differ in dip, apparently going under the gneiss to the north, which is normal in character, while that to the south is altered to a hard, flinty, sheared quartz-porphyry. Between the dyke and the altered rock are many small quartz veins. The greenish colour is imparted also to the gneiss on the outer islands, and no doubt indicates the near presence of a contact with the greenish eruptive rocks of the Huronian, which probably occupy the bed of the channel of the lake to the west.

Opposite Bull Head.

Opposite Bull Head and a little to the north, the banded green and reddish gneisses are again seen. At a small cove bearing N. 10° E. from Bull Head the rock is the typical banded granitite-gneiss very much broken by a heavy irregular green band running along the line of the strike. Through this are also many little bands and lenticules of red rock, which in many places have numerous angular cavities and in other places are made up largely of rock fragments. With these are also many irregular bands and strings of white crystalline calcite. A small creek near this empties into a cove, in the mouth of which is an island. This is too small to be shown on the map, but its position is directly east from Limestone Cave Point. At half a mile from the mouth the creek forks into two equal branches where the rock exposed is a reddish-gray gneiss, distinctly and evenly foliated, with a persistent strike north-west, and practically vertical or inclining slightly to the north-east. This gneiss is similar throughout, except for a few veins of milky quartz and red granite following the strike of the beds. Similar gneiss is seen on the lake-shore, and just south, at about half a mile, the great part of the exposed rock is a similar thinly-laminated gneiss, but on the extreme end of the point is a greenish-gray eruptive rock with which is a red band that weathers into a conglomerate-like mass, the larger crystals standing out from the decomposed ground-mass. This band is also well shown at the point near the stream, occupying a yellow sided trench. One hundred yards south the dyke appears to consist of a gabbro with chlorite, felspar, &c. Thinly laminated red and green schists strike along the shore to the south, inclining at a high angle towards the north-east, and in places the shore-line is in the form of a steep wall twenty to forty feet high. A great similarity in the exposures is noticed along this stretch, as the same beds practically occupy the shore to Loon Creek. Six miles north of the mouth of this stream the rock is a granitite-gneiss. It is inter-

East of Limestone Cave Point.

bedded with dark-green amphibolite bands and is cut by wide veins of granite. In many places it is much broken by small irregular faults, in the lines of which are veins of light-green epidote. The rock is probably more broken than any yet seen. It has a strike N. 40° W., and on the inside of the bay there is a light dip N. 35° E., but on the point the dip is to the south-west.

Loon Creek.

Loon Creek. Loon Creek was examined for six miles from its mouth. At the first rapid, two miles up it runs through two cracks in the rock, the larger one of which is about three feet wide. Below this the river is from one hundred to two hundred feet wide, but without current, and its banks are three to six feet high, composed of light-gray, alluvial clay, without boulders. Here and there a boss of gray gneiss crops out from beneath the clay. The banks are wooded with poplar and spruce up to twelve or fourteen inches in diameter. The rock at the rapid is a massive, gray granite or gneiss, with a very slight foliation N. 38° W., but does not at all partake of the character of the foliated gneiss hitherto described on the east side of the lake. The next rapid is a short distance above, and very similar to the first in character. The river above makes a long turn, first to the west and then north, and around to the south-east to a point a mile and a half north-east of the second rapid. In this distance two rapids are passed within a mile, and gneiss, similar to that on the lake, is again met with, running N. 57° W., and generally nearly vertical. At the most northerly point on the bend in the river, it expands into a little lake, one hundred yards across, on the east side of which there is a rapid over rock and boulders. To the north is a portage through woods for seventy-five yards. The rock is smooth and well glaciated in a direction S. 55° W. It is a similar reddish gneiss well foliated in a direction N. 58° W. Blue clay is present all along over the lower parts of the rock. Fourth rapid. At the last rapid, the fourth from the lake, the portage is over smooth rock of similar gneiss. From this smooth rock portage the river widens and runs between low wooded banks, covered with large spruce and pine. A short distance above the big bend the creek is divided, and is reported as coming from an extensive tamarack swamp. The upper reaches still show the underlying rock to be a banded gneiss, striking parallel to the lake-shore, but cut by many pegmatite veins running in all directions.

Shore of Lake Winnipeg—Loon Creek to Wannipegow or Hole River.

The shore-line from Loon Creek southward is not so regular in outline as toward the north. This is caused no doubt by the fact that the band of schist and greenstone which occupies the channel south from Dog Head, is not so deeply eroded beyond this point. A ridge of granitic-gneiss appears on Loon Island and along the shore south from Loon Strait. On the eastern side of this island and on the western side of Loon Bay the granite holds inclusions of the schists of the above mentioned band. General character.

On the western side of the island and along the shore for some distance the gneissic rocks are the only ones seen, but on some small rocky islands near the shore, east from Berry Island, inclusions of mica-schist are again noticed. These are probably fragments from Huronian rocks which outcrop on the islands of the Pipestone Island group and also on those farther south.

The line of this outcrop follows and gradually approaches the mainland and east of Pipestone Island, passes between the outlying islands and the shore. From Black Island to Hole Bay the mainland is of gneiss but apparently all the outlying islands are of Huronian rock.

The mouth of Loon Creek is filled with wild rice and blocked by a number of rocky shoals. The bottom of Loon Bay, west of the river, is low with a clay beach. The west side of the bay consists of low rounded rocks. On a point across from the river the rock was found to be a well-foliated light greenish-gray gneiss or amphibolite-schist with a strike N. 40° W., and dip S. 40° W. < 70°. In places the foliation is undulating, or affected by small abrupt twists. Running more or less with the strike are many bands of red granite and beside them are often little strings and pockets of epidote. Immediately back of the point it is found that the schist is followed by a massive greenish-gray granitite, with the crystals somewhat drawn out in a direction N. 30° W. It is cut by a few little strings of granite. Northward the schists are found to touch again on the point and also on the island beyond. The schist seen near the north-east end of the point is similar to that described above, but is there striking N. 53° W., and the point is cut across by a vein of red granite eight feet wide. Many little faults cut the schist in all directions, and along the lines of the faults are strings of light-green epidote. Many strings and lenticules of quartz are found between the beds. A short distance farther west, in the bottom of a little bay, the schist and the gray granite are clearly seen in unconformable contact. The schist dips Loon Bay. Unconformable contact.

under the granite, but the granite cuts it quite irregularly, cutting across the schist first at an angle of 10° to the foliation and then sending off a vein three feet wide into the schist at a much wider angle. Close to the line of junction the granite also includes many irregular, generally elongated, fragments of the schist. Small pockets of tourmaline crystals were observed in the schists not far from the contact.

Approaching Loon Strait, a small island, lying a quarter of a mile south-east, is found to be of similar green schist, cut by veins of red pegmatite running with the strike of the beds.

Contact of schists and gneiss.

On Loon Island the contact between the schists and gneiss is found to occur on two points on the east side. At the most northerly of the two the contact is clearly seen, and is much broken, the gneiss sending out long arms into the schist at a small angle to the general direction of the line of contact.

Loon Island.

At the middle point of the south side of the island, are several inclusions of hardened schist in the gneiss. The largest one runs out at both ends into the water, and one hundred feet of it is seen. Its width is twenty feet, and ten feet of gneiss is seen beyond it. On the east side a long arm of the gneiss runs into it. The border of the gneiss is fine-grained, for about six inches from the schist. The edge of the gneiss is practically vertical, but the schist dips south-west at an angle of from 60° to 70°. In places the foliation of the schists is twisted. In one especially, it bends round the edge of the gneiss, but generally it is cut off irregularly.

The west side of the island consists of low rock, rising from one to four feet above the water. It is a dark reddish-gray, massive granite-gneiss, cut by a few veins of coarse red granite. It also contains, as noted above, many large and small angular inclusions of dark-gray, laminated gneiss and schist. Small rocks in the bay to the south, are found to be generally massive gneiss, with the exception of one near the strait, which is of schist, probably one of the large inclusions noted above. The bay to the south is a long narrow inlet flanked on both sides with rock. That on the east side is generally low and slopes gradually into the water, while on the west it is more abrupt. The former contains inclusions of dark mica-schist, and is cut by veins of quartz and tourmaline. The latter is very uniform. All the gneiss is precisely similar to that on Loon Island, and has a general strike N. 58° W. The bay terminates to the south in an extensive marsh. It is possible, that there may be

water communication from this long bay out to the west, as the shore there is low and marshy. The points alone are rocky, with little rocky islands lying off them. A similar gneiss is found farther south along the mainland. The first exposure on the extreme western point is of a well-foliated gneiss, with alternating bands of gneiss and mica-schist. The foliation is generally much contorted, with a general strike of about S. 78° W.

South from Loon Strait.

A long low strip of shore is next passed in which the points and outlying shoals are composed of a reddish-gray granite-gneiss often broken by masses of red granite. The contortion in the beds appears to have affected the general strike of the rocks for a short distance. The end of the point terminating this fairly straight piece of shore-line shows a light green-gray gneiss, through which run bands of dark-gray mica-schist. The gneiss is very irregularly folded and crumpled, but the general strike appears to be about S. 78° W. and the dip S. 12° E. at an angle of from 30° to 48°. The gneiss is moderately fine-grained and like that at the last exposure contains a considerable amount of plagioclase, probably also with some orthoclase. Included in the bands of gneiss are some bands or lenses of hornblende-biotite-gneiss much like the gneiss farther south. On several points south of the small indents in the shore-line lying about north-east from Berry Island, the gneiss is found to be still much contorted, but the general strike is nearly parallel to the shore. Small veins of mica-schist cut across the foliation with occasional veins of red granite.

North-east of Berry Island.

East of Berry Island.

A low string of islands lying very near the shore and situated directly east from Berry Island, are composed of coarse biotite-gneiss showing very little foliation, but with several inclusions of dark compact mica-schist lying about N. 58° W. Some of these are lenticular with long tapering ends, and others are drawn out into beaded strings. Veins of dark-red granite also run in the same direction. These veins were especially observed on an island at the southern end of the group. Separated from the string of islands noted above and nearer the shore to the south, a small island is found to be composed of a greenish-gray quartz-diorite, quite massive, showing no sign of stratification or foliation. This is very much checkered by little cracks along which run strings of black hornblende or tourmaline with which are often lenses of quartz. It also occasionally contains large and small inclusions of pyrites. This island is about fifty yards from the shore, and the point opposite is composed of a dark-gray quartz-mica-diorite, showing a crystalline foliation in a direction N. 80° W. Into this gneiss, from the direction of the island, a mass or tongue, twelve feet wide, of fine-

Island of quartz-diorite

East of Pipestone Island.

grained amphibolite extends. The points south, to abreast of Pipestone Island show exposures of hornblendic gneiss, cut in many places by fine veins of granite. At one point, a band of massive, dark hornblende rock, abuts against the gneiss and strings of gneiss run out through it in many places, while many pieces of the amphibolite are included in the gneiss, often having the appearance of a true conglomerate. The small islands off this part of the shore show dark hornblendic rock, and the junction as seen above on the point, is no doubt that of an eruptive contact.

The group of islands extending along the shore, south from Pipestone Island are generally of the green schists and altered eruptives of the Huronian, but near the shore-line and on the mainland, the rock is a porphyritic gneiss. The contact line is apparently not seen, being no doubt under water.

Mouth of Rice River.

The bay into which Rice River enters, is denuded across ridges of this gneiss, leaving many islands as interrupted ridges running with the strike. The immediate basin in which the stream falls, is a long narrow bay with two entrances, nearly closed by a long island lying in front. The shore is here steep, rising to thirty feet above the water. It is composed of a crushed granite, similar to that farther north along the mainland. Some of it is massive, while much is schistose. The strike of the rock here is N. 33° W., the dip S.W. at an angle of 60°. A quarter of a mile to the east it is finer grained and has a distinct foliation. The strike is N. 23° W. and stands vertical. It contains several bands of fine-grained reddish granite along the lines of bedding; also interbedded with the lighter schist are some thin bands, of dark-green schist, with one lenticular band, having much the character of a coarse agglomerate or breccia. On the south side of the arm or bay, the rock is generally the same as on the west side, but it also varies, and dark and light schist is found in moderately thin bands.

Rice River.

On Rice River the section is across the strike, and gives a succession of dark porphyritic gneisses and some eruptives, followed farther inland by lighter coloured granites and gneisses. The river follows an irregular course, owing to the ridges of rock running across its general direction of flow. Near its mouth, at the first rapid, the beds are a gray gneiss, followed by fine grained dark beds, and at the head of the rapid an eruptive dark-green porphyry, in which large crystals of felspar are abundant. Half a mile across the strike the next exposure is of a gray granite-gneiss, with irregular or very indistinct foliation. The next exposure is about three-quarters of a mile across the strike, and is of a red gneiss evenly banded, which

again cuts across the river farther up. The gap in the section between this red gneiss and that at the first rapid, is probably occupied by altered eruptives, which probably are stringers of the dark band of rock, which forms the trough occupied by Loon Bay to the north. The dark gneisses and schists of Loon Bay are last seen striking southward, and the erruptive contact with the granite of Loon Strait would suggest that parts of the same band might be found to the southward of this granite. On Rice Lake the exposures are of a reddish-gray gneiss, followed to the east by gray granitite-gneiss, more massive, but with a slight foliation. The river averages about fifty feet in width, but is in many places obstructed by boulders, and in others very shallow and full of rice. The country is mostly rocky, with alluvial patches here and there. Rice Lake is very irregular in shape, and generally shallow, many of the arms being covered by a thick growth of rice. The shores are in places low and wooded. Above the lake the stream is sluggish for a couple of miles and the banks low and marshy, the country rising very gently. Knobs of gneiss bearing Banksian pine rise on every side, with intervening areas of muskeg covered with grass, bushes and small tamarack. The rock is a similar granitite-gneiss, foliated N. 48° W., with the surface showing glacial striæ bearing S. 60° W. In the upper stretches the river narrows considerably, and falls in several small rapids. The strike of the gneiss swings around to the north-east, the last observed being N. 55° E., and the dip S. 35° E. at a high angle. Rice Lake.

The shore, to opposite Black Island, is composed of similar gneiss ridges, generally high, dipping steeply into the water, cut by deep bays running in transverse to the shore, and approximately parallel to the direction of striation. It is wooded with aspen and a few spruce and scrub pine. Opposite Black Island.

The islands between Black Island and the mainland to the east are all of Huronian schist and greenstones, and the probable line of contact between the gneisses and granitites of the east shore and the Huronian rocks of the islands, follows very closely along parallel to that shore. The gneisses strike about parallel to the shore-line, and practically the same beds are followed south to the end of the bay near the mouth of Hole River. On a point almost opposite the north end of Black Island, the rock is a well-foliated gneiss, striking N. 22° W., and dipping S. 68° W. $<65°$. In one place it is cut by a thin band of granite. On the south-west it is interbanded with green porphyritic gneiss and on the north-east it lies against green, foliated, porphyritic gneiss. In many places the contact appears to be conformable, but in East shore south of Black Island.

others it is cut or gradually replaced by the green porphyry. This porphyry is seen again farther south, about opposite the east end of Black Island. It is a much altered and squeezed rock composed of quartz, felspar, biotite, chlorite and magnetite. The quartz is granulated and the felspar occurs in rather large individuals and very much kaolinized. The biotite is in minute scales largely altered to chlorite and scattered through the section. Calcite and epidote also occur. Altogether the rock has the appearance of a much crushed and altered granitic material and being very near the contact with the schists of the Huronian, it seems impossible to determine whether this may not be a much altered lower member of that series. At the south-east corner of the bay, just east of Hole River, the contact of the gneisses with the dark-green schists is very sharply defined. The schist has the appearance of a boulder conglomerate, the boulders lying in the line of strike with the schist drawn around them in thin bands. A great number of white veins of quartz are scattered through the schist in an irregular manner. From this contact the Huronian rocks are found skirting the shore to Clement Point.

Porphyry.

Contact with Huronian.

Pipestone Island Group.

The group consists of one island with a few trees growing on it, and a cluster of bare rocks extending in irregular order to the mainland to the south-east. The outermost rock lies about a mile north-westward from Pipestone Island in line with Berry Island. It is narrow, bare and about fifteen feet high, composed entirely of a massive dark-green, partly decomposed, eruptive. In one place it is crossed by a little band of green schist and dolomite. Green porphyritic gneiss is seen on the next island to the south. It is cut by masses of dark-green trap, probably dykes from a large mass to the south-west.

Pipestone Island group.

Pipestone Island is small and partly wooded. At the north-west end are abrupt cliffs fifteen feet high, while at the south-east end the shore slopes to near water-level. The middle of the island is about twenty-five feet high. The north-west side is composed of bluish, moderately thin-bedded serpentine, through which run a number of veins of fibrous serpentine mixed with magnetic iron-oxide. Some of the veins are almost entirely metallic. The east side is composed of a light grayish-green serpentine, some of which is calcareous; that which appears to compose the greater part of the island is much mottled with red. Through it are some veins of calcite and dolomite, or barite.

Pipestone Island.

Dykes on small islands.

On a small island to the north is a light-green, porphyritic gneiss dipping vertically and striking towards the north end of Berry Island. On the east side a narrow dyke three feet wide runs first with the strike of the gneiss, and then curves gently round to the north, crossing the strike and widening somewhat in places. In this cross portion many little strings run out from it into the gneiss, and in one place an elongated fragment was clearly seen in the dyke. The rock especially in the straight portion is quite schistose. From the north side of this island the dyke appears to cross to another island.

Half a mile south-east of Pipestone Island a small island one hundred yards long, consists of light-green porphyritic schist dipping vertically and striking north-east. It is cut by a vein of fine granite four feet wide running parallel to the strike. This island appears to be to the east of the line of contact between the gneisses and the green eruptives of the Huronian belt, but the next island south, an isolated rock about two miles south from Pipestone Island is composed of rotten, green rock, very irregularly jointed and fissured, which is probably Huronian. It is generally quite massive but on the south-west side it shows in some places a schistosity striking towards Berry Island. The rock, especially on this latter side, is altered to serpentine and along many of the fissure lines, oxide of iron has been separated out. The islands to the east of this are all of porphyritic gneiss similar to that of the mainland.

Islands in the Punk Island Channel.

Islands east of Punk Island.

The islands along the east side are mainly of the fine schistose gneiss, light-greenish in colour, striking along the shore. They are very numerous and rise out of moderately deep water and are generally wooded with poplar or Banksian pine. Behind, the shore is broken by inlets and marshes and the scenery in this vicinity is very picturesque. Toward Punk Island numerous small rocks appear but little elevated above the water and nearly all are of the dark-green eruptive similar to that on the islands immediately north near Pipestone Island. The outermost ones are distributed nearly along the centre of the channel. The southern one is of green chlorite-schist, and the one next to it to the north is composed at its eastern end of a comparatively coarse, light-green diabase in which many porphyritic crystals are clearly seen. This is striking west, and dipping south at an angle of 80°. It is evenly but not very distinctly bedded, and about seventy feet of beds is exposed. South of this, is one hundred feet of similar rock, but finer-grained, cut by thin anastamosing bands of chlorite-schist into oval masses three to six feet in length. This character is very strongly

marked and many irregular masses and ramifying veins of quartz are also present. South of this again thin bedded chloritic schists occupy the point of the island. Massive light-green diabase with a slight tendency to schistosity is shown on the next pair of islands to the north, the rock still striking westward. The most northerly of this lot, in the centre of the channel, is opposite the south corner of the east end of Punk Island and is of light-green, gray-weathering, rather coarse-grained rock, apparently almost massive but occasionally showing a slight foliation N. 60° W.

Islands near Punk Island.

Referring to the islands nearer Punk Island, a similar string runs south-eastward from near the south-east corner. On the first or northernmost group is seen amphibolite which weathers into a soft light-brown mottled schist. In places it shows very perfectly the ovoid structure remarked on one of the islands in the channel to the eastward. Coarsely granular, green schist crosses the next small island striking about N. 70° W., and dipping at a high angle south.

The rocks on the next three islands lying across the strike are all fine- and coarse-grained diorite, in some places showing a slight schistosity. Two islands lying farther to the south are both of dark-green, coarsely crystalline amphibolite.

Black Island—north shore and outlying islands.

Rocks of north-east shore Black Island.

The western part of the island is overlain by sandstones and limestones elsewhere described as of Black River and Trenton age, but along the shores of the eartern part, both north and south, dark-green schists and greenstones of Huronian age outcrop along the beach. The exposures on the north side are found to extend westward for about three miles and are mainly of dark-green eruptive rock. Bands of schists and slates probably of sedimentary formation, occur at the extreme eastern end and also on the point on the north shore of the island south of the largest outlier, but there is a greater variety of these rocks exposed on some of the islands just to the north. The rock at the extreme north-eastern corner, is a soft, silvery-white, sericitic mica-schist. This is followed at a short distance by a soft chloritic schist striking N. 10° W., dipping S. 80° W. $<$ 70°. In it some heavy veins of white quartz are included and with this are some streaks apparently of hæmatite.

For three hundred paces west along the shore, similar schist is seen, much of it glistening white on the surface. Scattered over it are many fragments of quartz. A short distance is then found covered

with sand, and the next exposure appears in rounded glaciated bosses of a more crystalline character, apparently an altered eruptive, although portions show a diabasic structure. The rock is mainly of chlorite, and extends to the first point where it shows a more porphyritic appearance. The islands opposite this bay show practically the same rocks, which vary from chloritic and sericitic schists to hornblende-schists, but farther westward darker schists are seen on the points lying just to the east of the small peninsula which here projects to the north-westward. On the eastern part of this peninsula the rocks are a tough blue felsite with a slaty cleavage striking N. 35° W., and dipping at a high angle south-westward. The shore along the outer or north-eastern part is generally high and about half of it, the eastern part, is composed of the felsite just mentioned, while the western part to the extreme end of the point, is occupied by an essentially massive dark-green or blue coarse-grained rock. On the north-western end it contains a number of angular fragments of the light-blue slate. A large number of islands lie to the north-east of this point, and on many of them, green schists are found striking in a westerly direction. On one of the large outer ones thirty feet high, green, epidotic, clastic schists are seen and on the neighbouring islands this is succeeded both on the north and south by massive coarse-grained eruptive bands. The schists of the inner islands are probably continuous with those that are noted toward the eastern end of Black Island.

Small peninsula.

From the end of the peninsula, westward for nearly a mile, the outcrops are of the coarse, dark eruptive, but a band of green agglomerate striking S. 70° W., appears on the outer part of the point. It is apparently only a few yards in thickness, and is followed a short distance in the bay to the west by a green rock showing a peculiar structure. It is composed of oval masses from three inches to two feet in length of similar green rock, and around these and cementing them together run thin bands of green schist. At the angles in these bands there is often developed a little mass of hæmatite.

Of the outlying islands it is a little difficult to place the descriptions, as the group is irregular, but the larger ones and many of the rocks appear to be made up of massive greenstones and schists which are squeezed eruptives. The most interesting exposures are on several small islands in the centre of the channel, between the end of the peninsula and the largest island to the north-west. The section from south to north across the strike shows the beds in the following order :—

Islands north of Black Island.

At the south end of a small island, green mottled rock of a massive type gives place to thin-bedded light-blue slate. This is interbedded with a green agglomerate in which the pebbles are at first few and small. They, however, soon become larger and more numerous, and the rock assumes a slaty character or rather is cut by a slaty cleavage striking S. 80° W., while the strike of the rock itself is due west. Farther north the agglomerate is nearly massive, and finally, at the end of the island contains pebbles three to five inches in diameter. Two small rocky islands farther on are of massive green rock and across a small gap the section is continued on another island. This is composed of agglomerate-schist on the south side, running into a thin-bedded chlorite-schist, while on the north side it is somewhat harder, and strikes west, standing vertical. This latter rock shows a slaty cleavage differing in direction from the strike.

Ferruginous boulder-clay of Black Island.

The remainder of the north shore of Black Island shows exposures mainly of drift-deposits and the soft sandstones at the base of the Trenton, but about midway along the shore a sandy till is found hardened by iron-oxide, and the shore is completely covered by dark-red slabs for four hundred yards along the beach. This ore is, no doubt, derived from the presence of iron oxides in the underlying rocks, which have been absorbed by the sandy bed lying immediately above, as a somewhat similar though less intense staining was observed on the sandy beds of the east end of Punk Island.

Black Island—south shore.

Drumming Point southward.

Drumming Point is an old Indian camping place and burial ground. The rock exposed at the shore is a well-bedded, wavy, green and reddish schist striking N. 25° W., and dipping south at a high angle. This is overlain by light-brown sand, which rises in an easy, grassy slope to a height of forty feet above the lake. The top is wooded with small Banksian pine. The shore runs to the south for a mile, and along it green schists are seen of the same wavy character, sometimes somewhat massive. Behind the point a deep bay runs to the north, from the end of which a road has been cut back into the bush. Following this for a short distance it ascends to a height of fifty feet above the lake, to the top of a sand ridge, probably a beach dune. Beyond this the country falls a little to a forest of spruce and pine. Near the shore some larch is growing, with spruce, balsam and poplar.

Islands to the east.

The islands in the channel between this part of Black Island and the mainland show the same green wavy schist as at Drumming Point,

but veins of quartz are noted on many of them. Those nearer Black Island, and near the mouth of the deep bay noted above, show green, chloritic schist running generally north-west, but on the island at the mouth of the bay this schist merges into a massive, green, granular trap on the west side of the island.

East end of Black Island.

The shore, from this deep bay south-west to the large island lying close alongside Black Island is quite irregular, and several small islands lie off it in a north-and-south line from the deep bay. These are of light-green schist, and on the most southerly one is seen dark-green trap, in places distinctly foliated and striking N. 28° W., dipping S. W. < 65°. The foliated bands contain bands of ferruginous schist and a considerable amount of vein quartz. The rock is well striated and overlain by a white till with boulders. The north point of the large island shows a green, well-bedded schist, striking N. 25° W. It includes small lenticules of quartz and lenticular beds of dolomite.

Adjacent islands.

Along the irregular shore opposite these islands, green schists and massive traps are exposed. The beach of the southern part is generally sandy, but along the northern, numerous boulders are piled on the shore, having fallen from the banks of soft blue clay behind. From the bottom of the bay, about midway along the sandy strip, a good foot-path is found, running back into the island to a favourite blueberry patch, to which the Indians resort during the berry season. Following this path north-westward for nearly a quarter of a mile, the ground is found to be all sand, and to rise gradually to a height of ninety feet above the lake. No boulders are seen, and the land is evidently immediately underlain by Palæozoic sandstone. A belt of spruce runs along the lake, growing on the alluvial clay, and the sand above is wooded with small spruce and pine. A terrace runs along at forty-five feet above the lake, which has every appearance of being an old shore-line. Above this, pine is growing, and below it, spruce and poplar.

Terrace, forty-five feet above lake.

The large island to the south appears to have few exposures of the underlying rock along its western side. On the north point, as mentioned above, are green schists. Along the inside shore, which is thickly strewn with boulders, mostly of gneiss, runs a little cliff of light-gray, sandy till, holding many pebbles and boulders. This is evidently a deposit of till, dumped behind the ridge of rock that forms the body of the island. At the end of the boulders and near the west point is an outcrop of mottled green, generally massive trap, showing oval structure in many places. Through it also run many schistose bands striking N. 40° W. It contains a considerable amount of pyrite.

The surface is well striated and over the sandy till is a band of four feet of light-gray stratified clay, evidently that which is commonly seen around the lake. The shore southward to the end of the island is largely strewn with boulders throughout, and is often backed by a little cliff of till with pebbles. The massive, green rock gradually gives out and is replaced by a light-coloured schist, striking along the shore.

South side of Black Island.

The exposures of Archæan rock on the shore of Black Island west of this, are all within a distance of a mile, with the exception of that at the centre of the island—the iron-ore deposit. On the first point west from the island just described is a hard gneiss rock, mostly massive but occasionally schistose. It contains arsenical pyrites, and in places shows the oval structure seen in the rocks of the north side of the island. It is cut by a few moderately wide veins of rather fine-grained red granite. A short distance west of this, the rocks are of soft, light green massive rock, associated with a hard, green schist, and nodules of quartz pyrite, hæmatite, &c. Some of the schists are quite silvery and strike generally to the west. Several shanties stand here, a small wharf is built at the next point, and a hole has been put down to a deposit of iron-ore, but apparently work has been abandoned.

The next exposure westward is of a green agglomerate, very compact and striking north-west. This is followed by a small outcrop of massive, green augite-porphyrite. From here westward the shore is generally formed from the sand or boulder-clay deposits which cover the main part of the island.

The deposit of iron-ore on this island has been described by Mr. J. B. Tyrrell in the Summary Report for 1889, and this description is here reproduced in connection with the general account of the rocks of the Huronian band of which it forms a part :—*

Iron-ore on south side of Black Island.

'Five miles and a half along the south-east shore from its south-west point, altered and highly inclined rocks are for the first time met with. They consist of light-green sericitic schists and quartzites probably of Huronian age, which are often externally reddened by oxide of iron. When first met with they strike N. 15° E. and S. 15° W., and dip at angles varying from 60° to 75°. These schists outcrop along the shore for a distance of 450 paces, forming generally a rough, irregular beach which slopes gradually into the water.

'Towards the north-east end of the exposure, however, a low rugged cliff rises above and behind the sloping beach, and on examination this cliff is found to consist in the centre of a mass of hæmatite, which

* Annual Report, Geol. Surv. Can., vol, IV (N.S.) 1889, pp. 16-18 A.

extends along the shore for a distance of a hundred paces and rises to the height of seven feet above the water. As shown in sections running back from the shore, it dips away from the lake at an angle of 30°, and in the vicinity of the mass of ore the bedding of the schist is almost entirely obliterated.

'The ore is a more or less pure hæmatite, not very compact on any of the exposed surfaces, and with numerous little seams and particles of crystalline calcite scattered throughout the mass, along with which are also a number of small lenticules and crystals of quartz. In some places, especially near the outside of the mass the hæmatite assumes quite a pisolitic or botryoidal structure, the spherules being often arranged in very well-defined rows, the interspaces of which are filled with calcite. Hæmatite ore.

'Towards the outside of the mass in places the ore has been converted for from a few inches to a foot, into a hydrated oxide of iron or limonite.

'No analyses have yet been made of the typical specimens collected during the past summer, but a number of analyses have been made of specimens previously sent in from Black Island, both in the laboratory of the Geological Survey of Canada and by Messrs. Gilchrist, Riley and Miller,* in London, England. Analyses of ore.

'These show an amount of metallic iron, ranging from 53·99 per cent downwards. None were found to contain more than a trace of phosphorus. One specimen gave on analysis 2·026 per cent of sulphur, the sulphur being present in the ore as finely disseminated iron-pyrites, while three other specimens show respectively 0·07, 0·12 and 0·032 per cent of this impurity. In the other five analyses the sulphur was not determined. No iron-pyrites was seen in the general run of the ore, but indications of decayed nodules could be traced in a very few places as yellow incrustations on the surface of the rock, and two or three small nodules were seen lying loose at the bottom of the cliff.

'As stated above, the deposit extends for about 300 feet along the shore, which has here a direction of N. 70° E., rises to a height of seven feet in the centre of the exposure, and dips back from the shore at an angle of 30°. The direction of its strike differs very materially from that obtained for the schists at the south-west end of the exposure, but in the immediate vicinity of the ore itself the bedding was entirely or almost obliterated, so that it was impossible to determine in the short time at my disposal, whether it was a true bedded deposit or a lenticular inclusion in the schists.

* Journal of the Iron and Steel Institute, No. 2, 1886, pp. 547-615.

Schists associated with iron ore.

'The hæmatite is underlain at the water's edge by a green quartzitic schist, and is overlain by a greenish-white argillaceous breccia from one to two feet in thickness. Overlying this is a mixture of quartzite (or infiltrated quartz) and rather hard green schist, containing a considerable quantity of hæmatite. This quartzose band is again overlain by light-green argillaceous on cericite schists, very much crumpled, but generally dipping at an angle of 60° and striking on the west side of the ore N. 50° E. and S. 50° W. Beyond this is twelve feet of light-green, soft, sericitic schist, and this then runs into the harder and more quartzitic schists, which comprise the rest of the whole exposure of Huronian rocks along this part of the shore.'

It may be of interest to note that Jeffry's 'Map of Canada and the north part of Louisiana' 1762, shows 'Iron Island' in Lake Winnipeg, a short distance south of the narrows, evidently referring to Black Island with its deposit of iron ore.

Islands in Hole Bay.

Islands in Hole Bay.

Opposite the western boundary of the Indian reserve, a group of small islands extends from near the shore northward to near the large island south of Black Island. On the northern island light-green crumpled schists are exposed. The strike is here S. 33° W., dip N. 57° W. $<$ 45°. In places the schist is soft and chloritic, while in others it is hard and quite silvery. The next two islands south show practically the same schist, but the strike swings round more to the west. On the western one, the strike is N. 10° W., and the dip southward $<$ 75°, and on the eastern one the strike is about west and vertical. On the large island to the north the beds run north-and-south, but turn to the westward on Black Island. In the group of islands to the south the strike bends round to the south-and-west, making a fold in the schists, one arm of which appears to touch along the south shore to near Clement Point. In the other islands in the group the strike is generally about east-and-west. The largest island, that nearest the south shore, is entirely made up of evenly bedded light-greenish brown-weathering schist, which breaks out in very long even slabs. This is evidently clastic and has probably resulted from the crushing of an arkose. The strike is N. 80° E., and the dip northward at an angle of 80°. It has also a linear arrangement of the crystals or an incipient schistosity at right angles to the strike, dipping S. 80° W. The surface is beautifully smoothed and grooved, the direction of the striæ, being S. 62° W., earlier ones running S. 23° $<$ 32° W. On the islands lying just to the north-east, similar rock is seen and included in it are a few

J. B. Tyrrell, Photo.

GLACIATED HURONIAN SCHIST, SHOWING EARLIER AND LATER STRIÆ AND GROOVING.
ISLAND IN HOLE BAY, LAKE WINNIPEG.

pebbles of granite. North of a long low sandy point, used by the Indians for a burial ground, somewhat similar schists or altered arkose is again exposed, found also to contain a few pebbles. The rocks are here vertical and the strike changes from N. 70° E. at the south to N. 57° E. at the north end.

A chain of small islands, five in number, lying in line from the mouth of the river to the east end of Black Island, show on the outer ones light-green schist, very much contorted. It has, however, a general dip S. 75° W. $<$ 70°, and the rock exhibits in this section evidence of very heavy crushing and alteration, principally of the felspar constituents. The original clastic structure is still recognizable. On the small rock, opposite the graveyard point, near the mouth of Hole River, altered arkose beds are exposed, probably a continuation of the beds which outcrop on the north side of that point, as the strike is here N. 80° E., or towards the point; the dip is southwards at about 80°.

Rocks of Dome and Red islands.

In the bottom of Hole Bay, clastic rocks, similar to those on the islands north of the west boundary of the reserve, appear on Dome Island, the largest of this small group. It is oval in plan, the longest diameter being parallel to the strike of the rocks. In a few places between the beds of the altered clastic rock, are found beds of green chlorite-schist. On Red Island, which lies just to the east, massive, green trap, cut by small veins of talc and dolomite, occupies the eastern part, while on the west side is an altered rock, consisting of a confused mixture of very numerous crystalline grains of calcite or dolomite, scales of sericite or chlorite, and yellowish stains of oxide of iron. The south shore is very much stained by the iron-oxide and some of the beds seem to be altered into a much harder and more compact form. The middle of the island is high and rough. The inner island, surveyed as a mining claim, is composed, on the west side, of the same beds as those on Red Island, while the trap forms its eastern extremity. The interior is composed of very much folded quartzite, hornblende-schist, &c., some of the bands being highly ferruginous.

Islands near Split-rock Creek.

Along the east shore, near the mouth of Split-rock Creek, are some small islands, three of them near the shore and two others farther out. Those near the shore show beds of altered arkose or greywacké. The strike is approximately parallel to the east shore, and included in the beds are strings of granite pebbles. In places interbedded with the greywackés are dark-green schists. On the island lying outside or to the west of the group this greywacké often is coarser grained and cut by many, often large, irregular veins of white quartz. A small rock rising six feet above the water, well out from the islands, is com-

posed of a schistose conglomerate, in which the pebbles up to twelve inches in diameter, are of granite and the matrix is of a very much contorted green schist, dipping about S. 65° W. < 40°. This conglomerate resembles very much that exposed on the islands near the east shore.

Wannipegow or Hole River.

Wannipegow River.

The valley of this river is denuded along the line of a narrow band of dark-green schist and eruptives, of Huronian age, and although the river follows the trough at the lower end, it cuts across it and touches a tongue of greenish-gray porphyritic gneiss before entering Lake Winnipeg in Hole Bay. The schists seen on the river above the Indian reserve appear to form a tongue extending to the west. It is thus represented on the map, as it is not probable that the schists end abruptly at the river. The band thus mentioned is denuded to form a trough for the upper part of the river and the Hole Lake basin, but near Lake Winnipeg it is partly divided by intrusive gneiss forming the centre of the peninsula ending at Clement Point. From the mouth, the course of the river follows along near the contact between the gneiss and the Huronian schists to the north-east, then it cuts across to the south and crossing the tongue of gneiss turns to the east and follows very closely along the strike of dark-green schists, which are apparently crushed greywackés.

The first exposure above the gneiss on the Indian reserve is a dark-greenish eruptive, in which the plates and crystals of hornblende are largely altered to chlorite, and the plagioclase to calcite. Massive, coarsely crystalline, hornblende-rock partly altered, is seen at the Indian reserve line, and above to the mouth of English River few exposures are to be seen of any rock. The banks are composed of clay, and rise from twelve to twenty feet above the river. They are evenly wooded with poplar up to twelve inches in diameter, mixed with which are a few spruce. Crushed greywackés are seen at the first and second rapids and on the long portage. These resemble a compact, dark-green, fine-grained hornblende-schist and include a few lenticular masses of quartz.

Hole Lake.

Several portages are made past rapids before reaching Hole Lake, and at each the dark schists are seen striking east, or slightly south of east, and standing vertical. In some places eruptives of the same dark colour appear, possibly interbedded, but at the entrance to the lake the schists are found intimately folded with a fine-grained greywacké, the clastic nature of which is shown in the microscopic section. The

foliation is very much contorted, and white vein-quartz is common in the rock. On the north shore, near the north-west angle, the beach is composed of boulders, while a bank of soft, gray clay rises behind them to a height of about fifteen feet, from which an almost level terrace extends back to the hills. These consist of green massive coarsely crystalline gneiss similar to that seen near the mouth of the river on the Indian reserve. It is cut by a few veins of red granite and comes out to the lake-shore half a mile to the east. From there on to the east the gneiss follows closely along the shore, and the schists form a narrow band. The contact was not seen, but it is noted that no granite veins cut the schists, but they cut the gneisses just beyond, and no inclusion of either rock is seen in the other. Near the east end of the lake the schist forms high hills along the shore, and the line of contact recedes somewhat from the lake, but numerous quartz veins or narrow strings of quartz, cut the schists. Massive greenstones are occasionally seen, but on the islands near the east shore thin-bedded schists occur striking S. 70° E., dipping northward at a high angle. The bedding is very wavy, and here and there in it are a few little strings of quartz. The south shore is indented with rounding bays, between which are well-glaciated points. The water is not deep and weeds grow all along the shore. The rocks strike generally along the shore, though at the east end the direction is sometimes to the south of west. The hills south from the eastern end of the lake show very hard compact light-green chlorite-schist striking west and standing vertical. Along the shore of the bay to opposite the mouth of the upper part of the river, green schists are followed by crushed and altered porphyrites, and similar porphyrites are found again at the south side of the outlet of the lake. Between these exposures all along the south shore dark-green schists are the only rocks exposed. These are probably squeezed eruptives associated with the porphyrites noted above. The southern edge of these rocks does not seem to be here well-defined and the south line of contact for all this area of Huronian is merely conjectural.

Contact with Huronian on Hole Lake.

The upper part of the river forms a long delta extending out into the lake for nearly three-quarters of a mile. The banks are rather low but are clothed with elm, ash, oak, poplar, birch and a little spruce. Above the delta the river becomes very crooked, winding from side to side of the valley and the banks rise gradually. About three miles up the first rock exposure appears and is of a hard, compact but thin-bedded, green schist striking east and dipping northward at an angle of 70°. Half a mile above, the river reaches the edge of the valley on the south side, and the green schists are exposed again. Shortly above

Upper part of River.

this the river swings to the north, and crystalline schists, apparently fragmental rocks showing much crushing, are exposed on the hill-side.

A cut-bank, fifty feet in height, on the north side of the river shows at the bottom twenty-five feet of evenly stratified sand, in places coarse and red and in others white and very fine. In the sand are some thin bands of fine, gray clay, in one of which, ten feet from the bottom, were found three pebbles well striated. Over the sand is twenty-five feet of evenly bedded, light-gray clay with a few calcareous concretions. The top of this high bank is level and extends back 100 yards to the foot of a rocky hill, rising in all 100 feet above the river. The sand and clay are probably lacustral deposits and form a terrace, fifty feet above the river, or fifty-six or fifty-eight above Hole Lake.

Above this the river is rapid and shallow with a sandy bottom, and in less than a mile rounded boulders make their appearance for the first time, and are thickly scattered in the bed of the stream. High banks of sand and clay show the valley to be well filled with river deposit in this upper part, and as the present stream does not now touch these, it is evident that a large stream probably, at one time, occupied the valley.

English Brook.

English Brook

English Lake lies in a basin to the north of Hole River, and the stream flowing from it, crosses the line of contact between the gneiss and Huronian, and then turns down the valley nearly parallel to Hole River for nearly three miles before joining that stream. The lower part is deep and about forty or fifty feet wide, without much current to the first rapid, two and a half miles up. Above that it is everywhere shallow and stony, often with a swift current. Below the first portage the country is largely alluvial, underlain by soft, dark clay wooded with poplar. Above, it becomes more rocky with little alluvial land. The rock exposures begin not far below the first portage and are of compact dark-green trap, in places schistose and undulating. A ridge of this rock runs up along the north side for half a mile, rising to one hundred feet above the river. The contact between the Huronian of the valley of Hole River and the gneisses bordering it to the north, occurs near the first rapid where bands of gneiss are first met. The portage is on the south side and is four hundred and seventy paces long, going back behind a ridge of the trap. A quarter of a mile above, another rapid occurs, and the rock shown there is a dark-greenish hornblende-granite, containing much

Contact of Huronian and gneiss.

plagioclase but no veins of granite. It seems generally massive, but in places it is foliated in a direction S. 65° E. and contains some strings of quartz. Before reaching the lake another rapid is met with, having a fall of thirty feet. The rock near the head of the rapid is a thinly foliated, gray gneiss with a strike N. 40° E. and a vertical dip. Near the head of the portage the rock is often much contorted, containing green hornblendic bands, lenses of red granite and strings of white quartz. To the north, a hill, one hundred feet high is composed of a similar gneiss.

English Lake.

English Lake is deep and free from weeds and the shores are everywhere bold, rising abruptly out of the water with hardly a vestige of a beach anywhere. The rugged hills, black and green with lichen, are thinly wooded with pine. The rocks are granite-gneiss and hornblende-granite-gneiss on the west side and gneiss and schist on the east side. The strike where they are not massive, is in the direction of the length of the lake or about north-east and south-west. They all dip north-westward at angles ranging from 35° to 75°. The basin in which the lake lies, thus seems to have been excavated along the strike of a band of gneisses and schists lying alongside a mass of unfoliated granite to the west.

Shore of Lake Winnipeg—Hole Bay to Clement Point.

Hole Bay, trap dyke.

The dyke of dark trap which was seen on the eastern edge of several of the small islands lying near the east shore, reaches the mainland near the bottom of Hole Bay. On the east side the trap abuts against the porphyritic gneiss which runs along the east shore, and includes and surrounds many large rounded detached masses. On the west side the dyke is bounded by contorted green schist, quartzite with much vein-quartz, &c. This does not here extend out as far as the greywacké, but a few yards to the south, on a parallel line, this latter rock is found to succeed the schist. The south shore, west of the angle where the dyke disappears, is composed of a massive, dark-green rock, a greatly crushed granitie containing chlorite.

Near Hole River.

West of this, at the mouth of a small brook, a band of soft, green schist runs into the crushed granite noted above, with a strike N. 45° W. and a vertical dip. The contact is fairly regular, though a few strings of schist run out into the crushed gneiss. Near the mouth of the river the rock appears to be a crushed greenish gneiss, somewhat resembling that of the east shore of the bay. In places it is quite schistose, and then strikes S. 80° W., dipping south at an

angle of 70°. A band of wavy green schist crosses this, however, in one place striking N. 5° W. The rocks are in high rounded bosses, making a rough rocky shore both here and all around the bottom of the bay. It is well striated on the surface, in a general direction S. 66° W.

West of Hole River.

At the bottom of the bay south of the point used as a graveyard by the Indians, the same greenish porphyritic rock is seen, but it is here cut by veins of green schist, that branch out very irregularly, having generally a much thickened triangular area at their junction They vary in width from half an inch to several feet. The end of the point, and half way down the side into the bay, is composed of a light-green quartzite grit striking west and dipping south at a high angle. The shore is thinly strewn with boulders, and overlain by blue clay up to ten or fifteen feet. The north shore is rougher, and the light-greenish grits standing on edge, run parallel to the shore and form cliffs eighteen feet in height and almost perpendicular. These grits are succeeded, in the same section, by coarser, partially recrystallized arkose sandstone, holding pebbles of granite, many of which are drawn out along the line of cleavage. Unfortunately the contact between the arkose and the porphyritic gneiss just to the south is covered, but a little point between the two exposures shows a very much reddened and altered rock, consisting principally of calcite and dolomite, stained by iron-oxide. The porphyritic gneiss appears on the shore just west of these cliffs and included in it are bands of green schist. They appear again at the point, which is the western extremity of the Indian reserve, and a mile to the west of this the point is occupied by green schists and the porphyritic gneiss. The contact shows the schist to be included in bands in the porphyry.

East of Clement Point

All along the shore to Clement Point, the greenish porphyritic gneiss is seen on the points, and green schists are caught up in it and strike in an irregular manner; but the small islands off the points show that the Huronian band must underlie the lake in the vicinity, and that the line of contact follows closely along the shore. Similar quartzite grit and arkose is exposed on two of the islands, and on a third nearer Clement Point, massive serpentine is found, much jointed and cut by veins of dolomite.

Contact following shore-line.

This shore thus shows beds referable to the Huronian only on the points, while the rocks to the south seem to belong to a similar series of squeezed and partly altered gneisses, with that found along the east shore of Hole Bay; and, probably the foliation becomes less distinct inland, as is also the case in that vicinity. The exposures on the

Hole River in the Indian reserve are probably parts of the same mass, and as is noted there, they are almost massive.

Shore of Lake Winnipeg—Clement Point to Winnipeg River.

Clement Point is long and low, and closely surrounded by a pavement of boulders, which are chiefly of granitoid gneiss, though a large number of the smaller ones are of limestone and a few of the slaty schist. No rock in place is seen and none of the boulders are very large. The point is overlain by a sandy clay, but a long beach of fine white sand leads up to it from both sides. Between these beaches is a piece of flat country ten feet above the lake. Many irregular cobbles of sandstone are seen, and at the second point in the bay toward Bad-throat River a small cliff shows sandy till overlying two feet of white and brown, stained, soft horizontal sandstone, an outlier of the basal beds below the Trenton. An island off this point shows a massive even grained granite broken by a few irregular jointage planes. Clement Point. Sandstone outlier.

The islands in this bay are all bosses of rock. One opposite the mouth of the river rises twelve feet above the water, and is of fine-grained gray granite, covered by stratified blue clay on which some spruce is growing. The beach from Clement Point to the mouth of the Bad-throat River is generally sandy, with the exception of a few boulders at two or three points, and no Archæan rock is to be seen except just at the river. The northern point is composed of an amphibolite-schist consisting mainly of hornblende and finely granular quartz as a matrix, and is derived probably from a diorite subjected to intense dynamic action. Manigotagan Bay. North shore.

South of the mouth of the river the rock is composed of a very compact dark-gray schist striking N. 62° W., vertical. The small rocky islands lying immediately west from this are found to be composed of a dark-gray evenly banded schist, somewhat coarser on the outer islands and more felspathic. In places on the outer islands the rock is almost massive or occasionally well bedded, but the strike is generally irregular. On the most southerly island of the group, red, coarse pegmatitic granite with a distinct lamination east-and-west forms the mass of the island. It includes many masses of coarse gray gneiss highly micaceous. In the largest of one of these is a wide vein of light-gray slightly micaceous gneiss that has probably been a vein of granite cutting the schist. On the main shore the contact of the pegmatite with the gneiss is seen. South shore.

Bad-throat River southward.

The shore from the river to this granite dyke or mass is composed mainly of dark-gray rock approaching a mica-schist. Toward McDermott Point the rock is a mica-diorite-gneiss becoming at the point a much coarser diorite-gneiss with less mica. The strike is here S. 24° W. with a dip westward $< 25°$. It is cut by many veins of granite, some of which are light, while others are dark-red and fine-grained.

McDermott Point.

McDermott Point is low and wooded with high poplar. Many low rocky shoals lie off it, apparently of dark gneiss. Along the shore to the southward the gneiss is seen to be very much cut up by granite dykes. Several points north of Sand River show exposures of dark epidotic granitite-gneiss very much cut by pegmatite veins. The strike is varied, but generally nearly east-and-west, and the dip varying from vertical to an inclination either to the northward or southward. From the point, to near the mouth of Sand River, the shore is low and apparently even, with a beach of sand and occasionally a few boulders. Bosses of rock are seen here and there rising above the beach. Their surface is generally smooth and glacial striæ are frequently seen. Two sets crossing each other were observed on a point north of Sand River, running S. 75° W. and S. 50° W.

For two miles north of Sand River the shore is about six feet above the lake, and the outer slope is often covered with grass. The beach is a soft clay and the country in the vicinity of the Sand River is low and flat. An alluvial plain stretches back up the river for a considerable distance.

Rocks on Sand River.

The point south of the mouth of the river is composed of low outcrops of massive, gray gneiss cut by veins of red pegmatite. It is massive, however, and contains much plagioclase. The mica is mainly altered to chlorite, and on the whole the rock is not so fresh as the exposures north of the river. The first rock exposure up the river is a dark-gray gneiss striking S. 40° E., and includes some irregular drawn out masses of mica-schist. The next exposure shows a boss of hornblende-granitite-gneiss, cut by a few narrow veins of red pegmatite. The highest exposure seen, about four miles from the mouth, consisted of a foliated granitite or biotite-gneiss striking S. 55° E., vertical. The river at first is from sixty to one hundred feet wide, but above the first rock exposure it is narrowed to about fifty feet. The banks are generally three to four feet high, level and dry, wooded with aspen.

Sand River southward.

The shore of Lake Winnipeg, south from Sand River, is generally low with a sandy beach, and low exposures of rock are seen near the water's edge. Dark-gray gneiss, cut by many wide veins of red granite, occurs near Sand River, followed by a long strip of low shore apparently showing no rock for a couple of miles, when coarse red granite

containing a few inclusions of the dark gneiss shows in a low exposure Low shores without any rock exposures stretch to within three miles of Black River. Half way a small reef shows the rock to be a red granite foliated N. 65° E. On the first point north of Black River, at a distance of about three miles from the river, the rock is a beautifully banded red and dark-gray gneiss. The red bands are often beaded; the dark bands appear to be epidotic and are probably decomposed rocks similar to the mica-diorites of McDermott Point. The strike appears to be N. 85° E., dipping S. 15° E. at about $< 70^\circ$. In the vicinity, the reefs and points to the south are all of a quartzose granite, rather massive, with a fairly definite foliation N. 65° E. At the mouth of the river, on the north side, are exposures of a red massive biotite-granite. Small exposures of similar rock are seen in the bay to the north and up the river for nearly four miles.

North of Black River.

South of Black River.

The point on the south side of the river is composed of a white granite, containing large crystals of felspar. It also holds irregular inclusions of dark-gray thin-bedded gneiss, striking S. 65° E., and is cut by a few veins of red granite. Many rocky reefs lie outside a line, joining this point with the points to the south, and at a distance of three miles the shore is cut back to the east, leaving a low point on which is piled a great number of transported boulders. Beneath, the rock is seen to be still of the same character as the last, with a more pronounced foliation, and somewhat darker and finer-grained. Many veins of red granite are seen cutting through the gray gneiss. In the bay to the south many boulders of gneiss and Trenton limestone are distributed along the shore. A low cliff of re-assorted till shows at its base, boulders with patches of hard compact till containing limestone fragments. The next point, a mile to the south-east, shows dark-gray, schistose biotite-gneiss, very much cut and broken by veins and masses of reddish and gray granite.

North of Point Metasse

Three miles from Point Metasse a high rounded rock forming a point, is composed of evenly banded dark-gray, schistose granitite-gneiss, striking S. 67° W. and dipping N. 23° W. $< 70^\circ$. It contains many interbedded strings of red granite, which in places swell into wide veins cutting across the gneiss, the latter becoming very much contorted. On the next point, past a few small islands showing dark gneiss cut by red granite veins, a gray epidotic granitite-gneiss well foliated S. 70° W., is cut by very few thin veins of red granite, and also long lenticular pointed strings of a darker, more massive hornblende-granitite. The edges along the lines of contact of the two gneisses are frayed, caused by the apparently broken ends of the gneissic foliæ.

Point Metasse At Point Metasse no rock is seen absolutely in place, but here and on the reefs off the point are many large boulders of gneiss. The surface is about twelve feet above the water and a scarped face shows it to be composed of a very sandy till with many boulders, evidently a morainic deposit. It is overlain to the south-east by a very well stratified dark-gray clay, holding toward the base a few pebbles, chiefly of limestone. Toward the mouth of Winnipeg River, the shore is mostly low with a beach of sand and clay. The country behind is from ten to fifteen feet above the water, and cliffs of stratified clay, at first in small exposures, are seen rising gradually to nearly fifteen feet as the river is approached. Very little rock is exposed and the first is on a small island, one mile from the river. It is of a dark, red and gray hornblende-biotite-granite-gneiss, striking east and west, cut across by a wide band of red granite. This granitite gneiss is exposed on the north side of the river for a mile and a quarter up from the mouth, and there comes in contact with large masses of a red biotite gneiss, which is cut by many veins running from the granitite.

raverse Bay.

Manigotagan or Bad-throat River.

Manigotagan River.

The river from its mouth to Jonasson's mill is deep and a quarter of a mile wide. The banks are composed of stratified blue clay without boulders, fifteen feet above the water and wooded with beautiful tall aspen and spruce,—a country evidently fitted for agriculture when the forest is cut down. At a mile and a half up, on the south shore, there is a little exposure of dark-gray micaceous schist striking east-and-west, dipping S. $<$ 75°. Along the line of strike run a number of little narrow lenticular veins of white quartz. The rock is generally covered by twelve feet of blue clay and shows glacial striæ running S. 57° W., while the lee side is equally well striated in a direction S. 27° W. The road from the mill to the falls, leads over good clay land and near the falls a ridge of mica-schist is crossed. The fall is twenty feet high, and the river at the foot is only forty feet wide. Steamboats run up to the foot of the fall. The rock exposed is here a dark-gray mica-schist standing vertical and striking N 85° W.

Above the falls, the channel is deep and seventy yards wide, with banks fringed with rice, behind which are thick woods of aspen with some spruce. Very few exposures of rock occur, and these consist of moss-grown points of dark schist, the same as that seen at the falls. The next portage, at Poplar Falls, is on the east side of the river, where there is a descent of fifteen feet. The rock consists of a dark-green thinly laminated hornblende-epidote-schist which assumes a

Poplar Falls.

gneissic aspect on one side and on the other passes to a fine-grained felsite. It strikes N. 60° E. and dips N. 30° W. < 70°. It is cut by many veins of red orthoclase-granite running generally with the strike of the gneiss and varying in width from three feet to fine strings. Just above, the rock is apparently massive, rising in high rounded hills probably of gneiss. At the next fall, a short distance above, the river descends five feet over a fine grained greenish and red biotite-gneiss with a generally massive appearance, but foliated in the same direction as at Poplar Falls.

Above Poplar Falls.

About a mile and a half farther up is another portage running up the left hand side of a rapid coming through a narrow cut between rounded gneiss hills. The portage is partly through low scrub and partly over a bare rocky knoll. The rock is a gray gneiss the same as the last with an indistinct crystalline foliation striking west.

The river in the last stretch is about the same width as before, but rounded bosses of rock are seen in many places, and the woods are thinner, of pine and small poplar. The rock all the way is a gray gneiss the same as at the last portage. At the foot of this portage light-gray alluvial clay without pebbles, is seen to five feet above the water. The higher parts of the rock are covered in the depressions with gray till with pebbles. Glacial striæ are not shown here, the rock being very much weathered and covered with a growth of lichens.

After passing a small rapid the next portage is on a small island. There is here a fall of three feet and the rock exposed is an orthoclase-biotite-granite-gneiss striking S. 70° E., cut by a few veins of red granite. At a sharp bend to the south the river is narrow, flowing between steep rocks and falling five feet. Past this there is a portage on the west side through the woods, over blue clay without pebbles, similar to the alluvial clay of Lake Winnipeg. Higher up, bouldery till is found on the rock. The rock exposed at the fall is a similar gray gneiss striking S. 85° E. The Cascade portage, about a mile above, is nearly 300 yards long through low bush on the east side of the river, past a cascade with a fall of twenty-five feet. The rock is a gneiss with a larger percentage of orthoclase than in the rocks below. The strike is about N. 60° E. The rocks here are cut by many veins of red granite, and the surfaces have been well glaciated, the north-east sides being rounded and the south-west, broken. The surfaces are everywhere weathered, so that most of the grooves and striæ are obliterated, but a few of the former are seen running S. 52° W. They are not on flat surfaces, but probably indicate the direction of ice flow very closely.

Cascade portage.

A small cascade of four feet, about a mile above the Cascade portage, shows similar gneiss striking N. 85° E., cut by a few veins of red granite. The river runs between rocky shores all the way, and up to the Smooth-rock portage, many small rapids occur, past which no portages need be made, while the general course of the river is quite straight, running approximately with the strike of the gneiss. High rounded bosses of rock show all along the banks, between which are little bays apparently underlain by light-gray clay, wooded with poplar. The shores are lined with rice and rushes. Red orthoclase-gneiss striking N. 85° E. and standing vertical shows at the Smooth-rock portage. A dark, banded gneiss or schist with lighter lenticular inclusions, is exposed at the next portage above. The country is generally low without much rock in sight, and is well wooded with white and black poplar, some spruce and a few oaks and ash. A little above this and opposite the mouth of a small creek, high hills rise on the south bank, composed of mica-schist very much folded, but generally striking up the river. The top of a hill, sixty feet high, is a fine-grained, white-weathering granitite-gneiss, with apparently no bedding and nearly massive, breaking readily when struck by the hammer. On each side of this are heavy beds of white, coarse, crystalline granite, folded with the bands of schist.

Smooth-rock portage.

Pillow Falls.

Above this the river runs along the strike of the rocks, and a ridge follows on both sides up to Pillow Falls. Here the rock is a mica-schist, striking S. 75° to 80° W. It is interbedded with a fine-grained granitite-gneiss in thick and thin bands along the strike, but also often in lenticular masses or strings, running out at both ends. In some bands of the schist the mica is entirely silvery white. Over the rock is a soft light-gray, slightly sandy clay without boulders, while in other places many boulders, chiefly of gneiss are scattered through a light-gray clay.

A mile above this beautiful fall is another of fifteen feet, at a low point in a ridge of schist which here crosses the river. It runs about east-and-west, and the river crosses it from the south. These ridges are probably formed by the presence of many lenticular bands and strings of a white pegmatite included in them, rendering the whole much harder than the surrounding rock. South-east of the schist, a wide band of massive, fine-grained, light-gray granite rises in rounded hillocks to a height of thirty-feet above the water, followed again by schist with lenticular inclusions of granite, etc., the same as that seen at the last fall, striking here S. 50° E., and dipping S. 40° W. $< 80°$. Occasional bands of schist were noticed in the granite area just passed.

The next portage is occasionally made by going up a short branch from the south and then carrying across the point. A short portage can, however, be made on the north side, near the rapid. The rock is a light-gray granite, but across on the south side mica-schist is seen dipping at a high angle, and many irregular fragments of schist are included in the granite which surrounds them on all sides. Below the rapid, on the north side, the schist is seen to abut against the granite, and is much folded and contorted at the contact.

Outlet of Turtle Lake.

From Turtle Lake, the river falls in a cascade of twenty feet, and at the foot the rock is a gray mica-schist in very irregular bands, very much cut and broken by irregular masses of red granite, the felspar of which is in places largely plagioclase. It is also cut by regular bands of the light-gray granite. The rock at the upper end of the portage consists entirely of the light-gray granite, and this rock forms the hills, ninety feet high, on the south side of the river, extending all round the south shore of the lake. These hills are conspicuously bare of all vegetation, and show out white, through the few stunted pines. The rock is in places very much cut by reddish granite veins, these in places composing about half the mass. Mica-schist is seen on the first point passed in the lake, and also across on the north side, but passes into a gneiss and then is so cut up by pegmatite veins that the foliation is lost.

Turtle Lake.

High hills of a bright red granite-gneiss rise on the south shore of Turtle Lake, while in the distance, to the south, the hills of white granite are also seen standing out in sharp contrast. The contact was seen only at one place, the two being separated by a vein of coarse red pegmatite.

Intrusive granite.

The white granite includes many bands of mica-schist, running approximately parallel to the contact, which is in general in a straight line, but in detail cuts the foliation of the schist. In another place the two are seen in sharp contact, and the white granite contains many inclusions of gneiss, which in turn also hold inclusions of the schist.

Above the lake to the next portage the river is nearly straight. The north bank is low, without rock and wooded with aspen. On the south bank mica-schist is exposed, striking parallel to the shore and dipping south $< 45°$.

Caribou Lake.

Four rapids with portages are passed before reaching Caribou Lake, and at each, mica-schist is seen dipping south, and south of the river the white granite hills are in view all along. Caribou Lake is bounded

by high hills to the south, while to the north, the country, though hilly, is more or less sloping and wooded, and the shore is very largely composed of boulders strewn along the beach. The rock exposed on the south shore consists of thin-bedded gneiss, striking S. 37° E., dipping south-westward $< 65°$, but on the north shore it is reddish granite-gneiss broken by many horizontal jointage planes. The foliation in this is very indistinct, and on the last portage before reaching Muskrat Lake, thin schists seem to be folded into it.

Muskrat Lake

Muskrat Lake, also called Rat Portage Lake, is irregular in outline, and, as will be seen from the map, consists of two bays, a large one on the west and the other narrower, running to the south, into which a small stream, the southern branch of the river, enters by a chain of little lakes. The northern branch enters the lake about a mile to the east of the outlet. The rocks observed along the shore of the western arm are mainly granite, but the north shore consists of evenly laminated gneiss and mica-schist, with white granite cutting it at the outlet and running approximately parallel to its strike, which is here N. 80° E. Near the north-west corner of the lake, red granite makes its appearance, cutting into the gneisses to the north, and it is seen that a large body or area of this coarse red granite occupies the country to the west and bordering the western shore, but the margin of the lake shows many exposures of very much altered gneiss, and many masses of various sizes are seen included in the red granite. Smooth rounded hills almost devoid of timber, rise to a height of ninety feet and occupy the country bordering the western shore, while the gneisses mentioned above, on the lake-shore strike in some cases towards this mass and in others to the southward along the shore.

The point between the two branches of the lake is mainly made up of red granite, but exposures of the gneiss are noted along the northern part. The eastern bay is mainly in a trough on the strike of the gneisses, while the narrow channel running to the south is in the red granite. At the inlet of the south branch of the river, a ridge of schists and gneisses running east-and-west cause a barrier, over which the stream falls fifteen feet, and above this is seen a wide lake-expansion with several islands. This is excavated along the strike of the schists and is evidently formed from the denudation of the softer beds. The islands are arranged in an interrupted chain from east to west, and are apparently formed from a band of gneiss. South of this, red granite again makes its appearance.

The northern branch of the river up to the first fall, which is ten feet high, runs between white granite on the north-west and thinly

foliated micaceous gneiss on the south-east side, striking up the river and dipping south-eastward at a high angle. The fall is of the character of a cascade flowing over the white granite. The next fall above is about twelve feet, and is over thin-bedded gneiss. The white granite is not exposed on the river above the first fall. Another mile up and a fall of twenty feet is passed, where a hard, fine-grained schist makes its appearance, striking N. 80° E., dipping southward at a high angle. This is a much sheared and stretched chloritic rock, a more highly altered stage of the micaceous gneisses of the lower part of the river.

Long Lake occupies the valley of the upper part of this stream, and discharges by a long shallow rapid, past which it is necessary to portage canoes. The rocks exposed are portions of the band of green schists seen at the falls just below, and their strike runs with the direction of the lake. Fine strings and veins of quartz were noticed cutting the schists, and in tracing these beds west they gradually merge into the coarser gneisses of the north-east shore of Muskrat Lake. The shores of this narrow lake are rounded hills of the green schist, with low land between, wooded with poplar and a little spruce. At a few places stratified clay, evidently alluvial, was seen. Long Lake.

Black River—north branch.

The two streams, the north and south branches of Black River, empty into a crooked narrow bay in the centre of the Indian reserve. These two streams are said to rise very near one another, but they spread apart and then gradually approach. The north branch is about the size of Rice River, and there are many rapids necessitating portages in ascending it to the long portage to Muskrat Lake. At the first rapid the river runs between two walls of red granite and falls about three feet over boulders. Similar granite is seen at the second portage, and at the third a well banded red and gray gneiss, probably near the junction of the red granite with darker gray gneiss, is seen. The strike of this rock is N. 50° W. At the fourth and fifth portages red massive biotite-granite, similar to that at the second portage occurs. Several small rapids are to be found between the fifth and sixth portages, and exposures of a light-coloured granite appear. The banks of the river in this vicinity are low and covered with poplar. Low exposures of the whitish granite, are occasionally seen with in one place a contact with a dark mica-schist, apparently a narrow band included in the granite. At the seventh and eighth portages the rock is a highly micaceous granitite-gneiss, cut by veins of the white granite. Above the eighth portage the river maintains its general width of about fifty Black River. Fourth portage. Eighth portage.

feet. The water is of a dark-brown colour, and slightly turbid. The banks are composed of clay, and are generally five to eight feet high, and wooded with poplar and a few large white spruce. Many ash trees overhang the river all along, and small oak grows on the rocky knolls. On the whole the country up to this point is rich and alluvial, the rock forming a very small proportion of the surface. Dark-gray gneiss, well foliated, running N. 70° E., occurs on the ninth and tenth portages. Interbedded bands of the white granite are found in the gray gneiss on the twelfth and thirteenth portages, and on the next two the bedding is indistinct.

The banks gradually rise and become more sandy, without boulders. The trees are Banksian pine, spruce, poplar, ash and elm. At the seventeenth portage, fourteen miles in a direct line from the mouth of the river, the rock is a dark-gray micaceous gneiss, nearly horizontal, or dipping N. 25° W. at about $< 20°$. At the next fall, or the eighteenth portage, the rock is a coarse, gray gneiss, rather irregularly foliated, but generally striking about east-and-west. The river from the last portage averages about forty to sixty feet wide, overhung with aspen, ash, and some large spruce. Here and there are little low exposures of thinly foliated gneiss generally dipping northward at about $< 70°$. The banks are from three to eight feet above the water. At Berry Rapid, the portage (nineteenth), is past a fall of six feet over smooth rock, a greenish-gray gneiss, with orthoclase and plagioclase, very irregularly foliated. Over the rock the soil is a white, sandy till. The winter trail from Fort Alexander to Muskrat Lake crosses the river just above Whirlpool Rapid, and seems to follow a sandy plain covered with Banksian pine. On the river up to the twenty-first portage, the banks are fairly level six to ten feet above the water, underlain by fine white sand. Low rounded bosses of gray gneiss occasionally project from either side into the river. Between the twenty-second and twenty-third portages, hills rise to fifty feet above the sandy plain which extends to the twenty-fifth portage. On the twenty-fourth, the gray gneiss exposed shows great crushing. About twenty-two miles in a direct line from the mouth, the river crosses an extensive muskeg, and above this rougher country is entered, rising in rugged and almost bare hills. A portage, the twenty-sixth, is at the east end of the marsh, where the rock is an evenly banded very much squeezed and altered gray gneiss, striking parallel to the river and vertical. In places it is interbedded with light-gray coarse granitite-gneiss, also very much squeezed. Winding through this rough country for a couple of miles farther, the river is found to issue from a long narrow lake-basin, now filled up, and forming a valley a quarter

Seventeenth portage.

Berry Rapid.

Twenty-fourth portage

of a mile wide, lying nearly east-and-west. To the south a short portage leads to a small lake on the head-waters of the south branch. The rock in this vicinity is of the dark-gray gneiss, striking E. 25° S. To the north similar rock is seen for several miles in long bare hills, between which are narrow beds of muskeg wooded with small spruce and larch. An Indian trail leads from this branch of Black River, by a series of small lakes and streams, to Muskrat Lake, on Manigotagan River. An Indian sketch is shown on the map, and serves as an indication of the route between the two points.

Black River—south branch.

The banks to the first rapid, half a mile south-east of the Indian reserve are sloping and alluvial, wooded with a forest of aspen. The stream here contains little over half as much water as the north branch, and the water is very dark and muddy. Above the rapid the stream is about forty feet wide and overhung with aspen. On the south side, is a low glaciated exposure of dark-gray hornblende-schist, containing in some places a considerable amount of pyrite. It strikes S. 25° E. and dips N. 65° E. at $< 40°$. It is cut by a vein five feet wide, of light reddish-gray pegmatite-granite. South branch

Winnipeg River.

The Hudson's Bay Company's establishment at Fort Alexander, is situated on the south-west side of the river, on the top of a bank of blue clay, that rises twenty feet above the water. The ground in the immediate vicinity is cleared, and behind is a forest of white poplar. The river water is brown but clear, flowing smoothly in a wide and deep channel. The fall from Lac du Bonnet to the level of Lake Winnipeg, is given as about one hundred and thirteen feet. This is mostly distributed at several beautiful falls and rapids, between which, the river-stretches are broad and deep. Upward from near the fort, the out-crops of the underlying rocks are mainly of red granite, and at the Manitou Rapids on the western edge of township 18, included angular fragments of red gneiss are frequent. The river there is narrow and deep, rushing between rounded bosses of rock. Pine Fall, two miles to the east, has a steep descent of over five feet and above are several lesser ones. At the fall similar granite and hornblende-granitite are exposed, and little foliation is seen in the granite at the short portages above. No boulders are noticed along this stretch of the river, the country being all covered by a thick bed of alluvial blue clay wooded

Winnipeg River.

Manitou Rapids.

with aspen. From these portages to Silver Falls on the north boundary of section 1, Tp. 18, R. X., little rock is seen, the banks being of alluvial clay, sloping up gradually to woods of aspen. At the falls the rock is a red hornblende-granitite, over which the water flows in a single cascade with a fall of twenty-five feet. Above Silver Falls the river is generally wide and with a light current. With the exception of two or three low rounded bosses of granite, the banks are composed of blue alluvial clay without pebbles or boulders, and wooded with aspen.

Silver Falls.

The end of this wide stretch reaches to the line between sections 31 and 32, Tp. 17, R. XI., where a cascade of twenty feet, called White-mud Falls, breaks over a mass of red granite containing a few inclusions of dark-gray gneiss, and cut by many veins of red pegmatite. At the lower end of the falls, the portage ascends over the clay to a height of thirty feet above the water, while at the upper end the bank is only ten feet.

White-mud Falls.

Another lake-like expansion after leading to the east for three miles, turns southward in a narrower channel to a rapid with a fall of six feet. On the north side a portage is made over smooth rock, a hornblende-granitite of light- and dark-gray colour. Above, to Big Bonnet Falls, the river has low rocky banks with clay generally filling the depressions. On the portage, which is three-quarters of a mile in length, a knob of granite protrudes through the clay at the middle of the distance, and toward the upper end the clay rises gradually to a height of twenty-five feet above the river. The next portage is at the west end of an island, where there is a descent of about four feet. Similar granite rock is exposed at several places in the interval, and at the portage it includes a few masses of a darker gneiss. The last portage to Lac du Bonnet is over the rocky end of a little island past a fall of five feet. The rock is a similar red granite, and the surrounding country is covered with but a slight thickness of alluvial deposit.

Big Bonnet Falls.

Lac du Bonnet.

Lac du Bonnet

The southern arm or continuation of the river extends to the southern edge of township 16, and the shore of the eastern part is generally low and wooded with poplar, with, occasionally, stretches of sandy beach and points consisting of rounded bosses of granite. The rock is a coarse, red, micaceous granite, quite massive, and free from inclusions and granite veins. The depressions in the rock, up to a height of eight or ten feet above the water, are filled with soft alluvial clay, and the shore is very free from boulders. The water close to the rock is clear

and in places deep, but in the immediate vicinity extensive beds of rushes indicate shallow water and a muddy bottom. Across on the west side, a band of reddish-gray gneiss, showing a slight banding N. 50° W., forms the point in section 14. The rock-surface is well-polished, and two sets of striæ were seen, the first running S. 25° W., and the later ones south-west. Boulders are scattered round the point, chiefly Archæan, with a few of trap and many of limestone. The surface is covered to a height of twelve feet above the water with a soft, gray, alluvial clay, and there is no sign of boulder-clay beneath.

The eastern branch of this lake, is shown on the map from a survey by Mr. J. B. Tyrrell. It is seen to consist of two expansions Around the shores of the first, red granites are the prevailing rock, but as the narrows to the second is approached, dark-gray gneisses and schists occupy the island in the channel and the point to the south. These strike S. 60° E., and appear very much squeezed and altered. The schist on Windigo Island, situated in the narrows, contains columnar individuals of tourmaline, and numerous patches of calcite and sericite or epidote, evidently a contact product. Reddish gneisses occupy the north shore, and strike about east-and-west. Windigo Island.

Around the south shores are found gneisses standing nearly vertical, running to the east. At the east end a depression in which the Oiseau River runs, seems to follow a trough of altered, eruptive and gneissic rocks. At the mouth of the stream the rock is a chlorite schist, showing intense crushing. Red and green schists, followed by a chlorite-schist, the altered form of an eruptive rock, are seen just to the north of the stream and strike up its valley. The north shore, with the exception of a point near the narrows, is occupied by greenish felspathic schists of fine grain, very dark in colour, striking easterly, and dipping northward < 55°. A mile east of Windigo Island fine-grained rock resembling a dark quartzite, striking S. 65° E., is followed to the west by coarser granitite-gneiss striking about east. The contact between these last two is not noted, but the strike and dip of the dark rocks is not apparently parallel to the coarser gneiss, and the probability is that the contact is an eruptive one and that the rocks of the valley of the Oiseau River are part of a lenticular area of Huronian, pinched out altogether, west of Windigo Island. Oiseau River. Huronian rocks.

Winnipeg River.—above Lac du Bonnet.

Above the lake the river is a beautiful quiet stream but with swift current where rounded bosses of massive reddish granite contract the

channel. In the southern part of township 15, the rock is overlain by blue alluvial clay, which rises to a height of fifteen feet above the river, and then apparently extends back in a level plain, wooded with poplar. On the beach are many boulders of limestone, both mottled and cherty, The first exposure of till is found on section 6, Tp. 15, and is compact and white, with many pebbles of limestone. The till is just such as has been found to be derived from the vicinity of areas of Trenton limestone, and evidently indicates the presence of it in the vicinity. Through Tp. 14 the river flows with a constant swift current, in a few places forming rapids where obstructed by boulders. A very few low exposures of rock are seen, all of granite, but the banks are very uniform and from twenty to thirty feet high, composed of an unstratified white till, containing boulders of limestone and gneiss. This till is overlain by a few feet of dark blue-gray alluvial clay. In section 5, Tp. 14 an outcrop of coarse biotite-gneiss rises five feet above the water, striking N. 70° E. and standing vertical. It is essentially the same in composition as the granite of the lower part of the river. No Cambro-Silurian limestone or sandstone was seen in place, but a number of little creeks flow in from the west side, which may be fed from the sandstone. Up

Whitemouth River.

to the mouth of Whitemouth River the banks are about the same as lower down, except that there are more rock outcrops. The latter stream flows into Winnipeg River over a smooth ledge of rock with a descent of about ten feet. The rock is a dark-gray, well foliated hornblende-granitite-gneiss, striking east and standing vertical. It is cut by veins of fine-grained gray granite and again by many veins of a coarse red granite. Light-gray till everywhere overlies the rock, and the country is well wooded with poplar and a few oak.

A small island, just off the mouth of the river, has its surface well smoothed and glaciated in a direction S. 63° W. and it also shows another and earlier set of grooves running S. 30° E. The next little island further up the river has a wide flat surface and shows the glacial markings very much better, The later set being seen to run S. 60° W. and the earlier S. 33° E.

Shore of Lake Winnipeg—Winnipeg River to Red River.

Catfish Creek.

From Fort Alexander to Catfish Creek a bank of stratified clay from ten to fifteen feet high extends, generally scarped by the washing of the waves against its base and often beautifully carved out to little caves and pillars. Catfish Creek is a small but deep, sluggish stream thirty feet wide, and overhung with willows. It rises just west of Lac du Bonnet and flows through a muskeg for a great part of its

course. From Catfish Creek to the next one west—Jackfish Creek— the shore is very similar to that to the east. Sand spits run out into the lake and the shore is shallow. Sand beach forms a long strip bordering the shore to the corner of Tp. 19, R. VII, and behind this stratified clay continues in a cliff of ten feet. Boulders then become thickly strewn along the beach and the bank behind rises with a moderate slope to a height of thirty feet. The top for about six feet is composed of a sandy till with large and small boulders, having the appearance of a ground moraine; below, the soft beds of the Winnipeg sandstone appear to extend down to the water and are seen for about a mile along the shore. A low strip of country extends across the narrow isthmus which is the southern part of township 20, R. VII. The eastern side of the peninsula is higher than the west and is very similar in contour to that of Elk Island just to the north. Beds of stratified sand and clay form cliffs very similar in appearance to the Winnipeg sandstone and probably the peninsula has a nucleus of these beds. The north shore is of boulder-clay with a level surface fifteen or twenty feet above the lake, and the beach is thickly strewn with boulders. On the west side many large slabs of mottled, Trenton limestone containing *Maclurea Manitobensis*, etc., are lying, evidently close to the parent rock. Behind the beach in section 15, is a cliff twenty feet above the water, composed chiefly of clay, often with many large and small boulders.

Jackfish Creek

South of Elk Island.

South of the point in Section 16 is a high cliff of sand, which is probably recent and not part of the Winnipeg sandstone. The west point of section 9, is a cliff of clay thirty to forty feet high, very sandy and containing some interstratified beds of sand and also some boulders from the soft sandstone beneath. South-east of this the land lowers and is composed of till, occasionally overlain by a little blue clay. A beautiful harbour is formed in the bay between this peninsula and the mainland to the south, by a bar of sand and gravel reaching out from the south. The country in the vicinity is wooded with poplar and spruce, but about fifteen feet above the lake, a level green sward of short grass affords a good camping place.

Point Grand Marais.

Point Grand Marais is surrounded by boulders and behind them is a cliff forty to fifty feet high, composed apparently of sand containing many large boulders. This forms a narrow terrace with low land behind. A deep bay on the north, across the mouth of which two bars nearly meet, forms a natural harbour. Opposite the marsh, to the south, a sand-bar terminating in a hook, also affords shelter for small vessels. The land east of the bay rises to the north and from the northern part of Sec. 33, Tp. 18 a smooth sandy plain rises with a

gentle slope to a height of thirty feet above the water, while on the beach at this latter point is a low exposure of dark-blue alluvial clay. Another terrace above is here also noticed with a steeper slope. This rises to an additional height of thirty-six feet or a total of sixty-six feet above the lake. Its surface is a level sandy prairie wooded with occasional pine, and its scarped face shows it to be composed of horizontally stratified alluvial sand, with pebbles of gneiss, etc. Crossing this terrace with a width of about two hundred yards on the Fort Alexander trail, another moderate sandy slope strewn with large boulders is ascended to an additional height of sixty-five feet or to a total height of one hundred and thirty-one feet above the lake. The top has a moderately even surface of coarse sand with a few boulders in some of the depressions. This ridge runs N. 25° W. and S. 25° E., and beyond, past a depression running parallel with it, is a hill of about the same height. This has undoubtedly a morainic centre, probably deposited in shallow water.

South of the marsh at Grand Marais the beach to Balsam Bay is composed of boulders, behind which is a cliff ten to twenty feet high, composed of sandy till containing boulders.

Balsam Bay.

At Balsam Bay, the land rises to a terrace about thirty feet above the water behind which, on the trail back from the lake is a sloping sandy plain, dotted with a few boulders, terminating in a more abrupt slope, at the top of which is a rounded ridge, fifty feet wide and three feet high, composed of rounded cobbles. This is clearly an old shore-line and is probably about sixty feet above the lake. Behind it the sandy hill or ridge, rises to a height of about one hundred feet above the lake, the summit being often composed of many boulders set in loose sand. At three-quarters of a mile from the lake the land falls again to a wide valley in which there are no boulders. Gray sandy and pebbly till is also seen at many places, on the surface.

Big-stone Point.

From Balsam Bay a marsh extends towards Big-stone Point and a sand-beach runs along in front of it through which there is but one narrow gap. Big Stone Point is the end of a dry, level meadow about five feet above the water, surrounded by a ridge of limestone gravel. This gravel is more or less rounded on the east side while on the west it is angular, and towards the point is often in large blocks. It is a mottled, Trenton limestone and there are but few granite or other boulders on the point. In view of this latter fact it appears probable that the limestone is shoved up by the ice from rock in place, beneath the water on the west side of the point. It is possible that it is derived from boulder-clay, but the extreme scarcity of granite boulders

and the want of granite pebbles and sand, would make this improbable. From Big Stone Point to the mouth of Brokenhead River the shore is low and sandy and this character is maintained to the mouth of Red River.

Brokenhead River.

The mouth of the river is obstructed by a sand-bar, but within it has a well-defined fairly straight channel through the marsh up to the northern side of the Indian reserve, where the land rises slightly and is dry and wooded with poplar. At the lower part of the bank the till contains numerous limestone pebbles; on the top there is, however, a thin layer of alluvial deposit. The river above becomes winding with reeds on the inner side of the bends. About one and a half miles up, within the reserve, on the west side of the river, the bank is twelve feet high, and shows nine feet of mottled Trenton limestone. A little more than a mile farther up the river, a somewhat similar exposure of limestone is seen on the east side. Just above this the river becomes shallow and obstructed by boulders and maintains this character for half a mile, when it becomes narrow and flows between boulders, with a total fall of about four feet. Here the east bank is sloping while the west bank is steep and occasionally scarped, showing it to be composed of a light-gray, unstratified till with many pebbles and some boulders, almost all of limestone. On the bank, too, are many angular masses of mottled Trenton limestone evidently out of the till, but probably not far from beds in place.

Brokenhead River.

APPENDIX I.

LIST OF GLACIAL STRIÆ.

Glacial Striæ.

Stonewall	S. 25° E. and S. 10° W.
Stony Mountain	S. 19° E.
Assiniboine River—	
Sect. 23, T. 9 R, X	S. 38° 30′ E.
Saskatchewan River—	
Below Roche Rouge	S. 12° 30′ W.
At Roche Rouge	S. 12° W.
Grand Rapids (bottom)	S. 2° 30′ W.
" " (middle)	S. 62° 30′ W.
" " (top) second set	W. 2° 30′ N.
Cedar Lake—	
Island, east of Rabbit Point	S. 18° 30′ W.
Mouth of Saskatchewan River	S. 39° W. and S. 65° 30′ E.
South-east shore	S. 19° 30′ W.
Lake Winnipeg—	
Near Buffalo River	S. 2° W. and S. 22° W.
" " "	S. 37° 30′ E. to S. 57° 30′ E.
Robinson Point	S. 2° W.
Head of Nelson River	S. 54° W.
Near Montreal Point	S. 35° W.
Spider Island Point	S. 30° W.
Spider Islands	S. 34° W.
Mouth of Belanger River	S. 32° W.
North of Belanger Point	S. 23° W.
Belanger Point	S. 20° W.
From Belanger Point to Black River	S. 48° W. to S. 22° W.
Mouth of Big Black River	S. 23° W.
H. B. Co.'s Post Poplar River	S. 40°-48° W.
Poplar Point	S. 37° W.
Marchand Point	S. 32° W.
Island in Berens River Bay	S. 57° W.
Berens River, H. B. Co's. Post	S. 57° W
Pigeon Point	S. 56° W.
" earlier striæ	S. 18° W.
Pigeon Bay	S.17° W., S.38° W. and S.57° W.
Flathead Point	S. 53° W.
Rabbit Point	S. 58° W.
Opposite Dog Head	S. 54° W.
Opposite Limestone Cave Point	S. 48° W.
Opposite Bull Head	S. 53° W.
Mouth of Loon Creek (earlier)	S. 5° W. to S. 30° W.
" " (later)	S. 55° W. to S. 70° W.

Lake Winnipeg—*Concluded.*

Loon Island (earlier)	S. 30° W.
" " (later)	S. 55° W.
N. E. point Black island	S. 62° W.
North shore Black Island	S. 63° W.
South side Black Island	S. 57° W. and S. 65° W.
Mouth of Hole River	S. 66° W.
Hole River to Clement Point	S. 53° W. to S. 58° W.
Badthroat River (earlier)	S. 27° W.
" " (later)	S. 57° W.
McDermott Point	S. 45° W.
North of Steep Rock River	S. 57° W.
Island near Dog Head	S. 50° W.
Near Sand River	S. 15° W. and S. 50° W
South of Little Black River	S. 54° W.
Mouth of Winnipeg River	S. 57° W.
Black Bear Island	S. 49° W.
N.W. end Little Tamarack Island	S. 51° W.
Jack Head Island	S. 26° W.
Berens Island	S. 56° W.

Badthroat River—

Portage No. 7	S. 52° W.
" No. 18	S. 57° W.
Caribou Lake	S. 62° W.
Muskrat Lake—	
South side	S. 62° W.
East side	S. 60° W.
Long Lake	S. 60° W.
Hole River, east boundary of I. R.	S. 65° W.
" first rock	S. 75° W.
Hole Lake, south shore	S. 68° W.
" west end	S. 73° W.
English Lake, east end	S. 63° W.
Rice River, upper part	S. 62° W.

Little Black River—

Portage No. 3	S. 55° W.
" No. 10	S. 60° W.
" No. 24	S. 65° W.

Winnipeg River—

White-mud Falls	S. 55° W.
Outlet of Lac du Bonnet	S. 60° W.
South side, Lac du Bonnet	S. 62° W.
Near east end, Lac du Bonnet	S. 25° W.
Point in sect. 14, T. 16, R. XI	S. 60° W. and S. 25° W.
Mouth of Whitemouth River (earlier)	S. 27°–30° E.
" " " (later)	S. 60°–63° W.

Playgreen Lake—

Opposite Old Norway House	S. 45° W.
Goose Island	S. 45° W.

Little Playgreen Lake—	
At Mission	S. 52° W.
On islands	S. 52° W. and S. 60° W.
Mouth of Nelson River	S. 36° W.
McLaughlin River—	
Near first lake	S. 32° W.
Between first and second lakes	S. 20° W.
Upper lake	S. 41° W.
Gunisao River—	
At several places above forks	S. 30° W.
Near Gunisao Lake	S. 11° W.
East end, Gunisao Lake	S. 16° W. and S. 11° W.
Upper Gunisao Lake	S. 11° W.
Belanger River—	
Fourteen miles up	S. 21° W.
At forks	S. 27° W.
Near head of river	S. 17° W.
Black River—	
First rapid	S. 25° W.
Pelican portage	S. 3° E.
Poplar River—	
Ten miles up	S. 32° W.
White Mud portage	S. 20° W.
Thunder Lake	S. 35° W.
Etomami River—	
Willow portage	S. 60° W.
Eight miles below Boulder Rapid	S. 57° W.
Pigeon River—	
Six miles up	S. 58° W.
Three miles below Poplar Falls	S. 64° W.
Five miles above Poplar Falls	S. 64° W. and S. 34° W.
Near Jack River portage	S. 64° W.
Bloodvein River—	
Four miles above Little Bloodvein River	S. 58° W.
Sasa-ginnigak Lake	S. 57° W.

APPENDIX II.

NOTES ON EARLY TRAVELLERS ON LAKE WINNIPEG WHOSE RECORDS OR REPORTS CONTAIN DESCRIPTIONS REFERRING TO THE LAKE.

De la Verendrye, 1734–1739.

In March, 1734, the eldest son of Sieur de la Verendrye descended Winnipeg River from the Lake of the Woods, and probably reached Lake Winnipeg; and in the autumn of the same year, one of his sons descended the river and built Fort Maurepas on the north side at the mouth.

On the 16th of April, 1739, being at Fort la Reine (Portage la Prairie), Verendrye sent his son, Pierre Gautier, with an Indian to make an examination of the bottom of Lake Winipigon, of the mine which is on the lake and of that which is on White River (probably the Saskatchewan, which is called White or Hinds River on Jeffrey's map of 1762) of the outlet to the lake, to go round it, to endeavour to hinder the Indians from going to the English.

(Découvertes et Establisssements des Français dans l'Ouest, &c. Journal de Laverendrye. Canadian Archives. Report 1889, p. 26.)

Joseph La France, 1740–1742.

In a book entitled "An Account of the Countries adjoining to Hudson's Bay, by Arthur Dobbs, London, 1744," there is an account of this traveller. His father was a French trader or trapper and his mother a Sauteau. La France was a native of Michilimackinac, and lived for a short time in Quebec and Montreal, but spent the greater part of his life—up to the age of 33 years, around lakes Huron and Superior. He had been denied a license to trade, by the French Governor, and in 1739, while on his way eastward with furs, he met a brigade of canoes in charge of French soldiers. By them he was seized and all his effects confiscated, but he managed to escape to the woods with but his gun and five charges of powder and ball. He then determined to make his way to the English on Hudson Bay. In the beginning of the winter he set out on his journey. In the spring of 1740 he reached the Grand Portage and from there he descended the Rainy and Winnipeg rivers, in September reaching 'Ouinipique' Lake. He spent the autumn and winter hunting beaver with

the Crees on the north-eastern side of the lake. He describes the lake and the Indians who inhabit its shores. He speaks of the lake being no more than ten leagues wide and in some places not above a league and a half. The outlet is into the 'Little Ouinipique' by a river he calls the Red River, or 'little Ouinipique,' after a course northward of about sixty leagues. 'This lake is thirty-three leagues long and six broad. There is but one little island in it, almost on a water level, called by the Indians 'Mini Sabique.' The course of this lake is north-and-south through a low woody country. To this La France descended in a canoe in the summer of 1748. 'He passed this lake and the river that runs into Lake Du Siens [sic] in summer and autumn; this is about 100 leagues from the other.' Lake Du Siens is three leagues in circuit and full of wild rice. He spent the winter of 1741-42 between Lake du Siens and Lake Cariboux. This lake is ten leagues long and five broad. From here he travelled eastward fifteen leagues to Pachegoia, or Lac des Forets, from which he descended to York Factory. 'Pachegoia is divided so as to make about two lakes.'

In the work above referred to, are also descriptions on pages 20-21, of Nelson River and Lake Winnipeg. It is described as coming from another lake called the 'Junction of two Seas,' because the land almost meets in the middle of the lake. 'The west side is full of fine meadows filled with wild oxen. This lake is 400 leagues in circumference.'

" A hundred leagues west-south-west along the river is another lake they call Ounipigouchih or the Little Sea. It is 300 leagues in circumference; at the further end is a river which comes from Tacamiouen, which is not so great as the other; it is into this lake that the river of Stags is discharged, which is of such length that the natives have not yet discovered its source. From this river they can go to another which runs westward.' This is evidently from information from Jeremie. (See Dobbs, p. 54.)

Alex. Henry, 1775.

On the 16th of August, 1775, Alexander Henry reached Lake Winnipeg on his way from Montreal to Churchill River. At the mouth of Winnipeg River he found a village of Cree Indians, and he has given an interesting account of their customs and general appearance. Journeying along the lake he passed Pike River on the first of September, to the west of which, he states, 'is a rock of great length called Roche Rouge, and entirely composed of a pierre à calumet, or

stone used by the Indians for making tobacco pipe bowls, It is of a light red colour interspersed with veins of brown and yields very readily to the knife.' Probably the cliff at Cat Head.

(Travels and adventures in Canada, by Alexander Henry, Esq. New York, 1809. 12 mo.)

DAVID THOMPSON, 1790–1812.

In June, 1790, David Thompson, then a clerk in the service of the Hudson's Bay Company, started from Cumberland House on his way to York Factory. While on his journey he made a track-survey of the north end of Lake Winnipeg—the first systematic survey that was made on the lake. During the succeeding twenty-two years, he crossed the lake and surveyed its shores a number of times and on his map of the North-west, made in 1813-1814, its contours are first laid down with a reasonable degree of accuracy.

A. HENRY, JR., 1799–1808.

Between 1799 and 1808 Alexander Henry, Jr., was in charge of trading posts of the North-west Company in the Red River district, and crossed Lake Winnipeg several times from the mouth of Winnipeg River to that of Red River. In the latter year he travelled along the west shore to the Saskatchewan River on his way to the plains. He notes many interesting points about the early history of the country.

(The Manuscript Journals of Alex. Henry, edited by Elliott Coues, 1897.)

SIR A. MACKENZIE.

In his 'General History of the Fur Trade' in the first part of his 'Voyages' Sir Alexander Mackenzie gives a general account of Lake Winnipeg and the rivers that flow into it. In several places he makes slight references to the underlying geological structure of the country. In speaking of the Red and Assiniboine rivers he says:—'In some parts there are rapids, caused by occasional beds of limestone and gravel; but in general they have a sandy bottom. This lake in common with those of this country, is bounded on the north with banks of black and gray rock and on the south by a low, level country, occasionally interrupted with a ridge or bank of limestones, lying in stratas, and rising to the perpendicular height of from twenty to forty feet; these are covered with a small quantity of earth forming a level surface, which bears timber, but of a moderate growth and declines to a swamp.'

Limestone is also mentioned on the Saskatchewan at the Grand Rapids and above.

(Voyages from Montreal, by Alex. Mackenzie, London, 1801, 4to pp. lxiv and lxvi.)

Daniel W. Harmon, 1800–1819.

D. W. Harmon in 1800 crossed Lake Winnipeg from the mouth of Winnipeg River to the mouth of the Little Saskatchewan River on his way to Swan River, and in 1805 having descended the Assiniboine he crossed from the mouth of Red River to Winnipeg River. The same year he returned west to the fort on the South Branch and in 1807 again returned to Winnipeg River on his way to Fort William. In 1808 he crossed the lake on his way to Peace River and thence to New Caledonia. In 1809 he passed east by the same route on his way to Montreal. Though his journal is interesting, as giving much useful information about the character of the country and its inhabitants at that time, he nowhere speaks about the rocks or soil around Lake Winnipeg.

(A Journal of Voyages and Travels in the interior of North America, by Daniel Williams Harmon. Andover 1820.)

Abel Edwards, 1812.

'Notes taken during the summer of 1812, on a journey from York Fort, Hudson's Bay, to Lake Winnipeg and the Red River, by Mr. Abel Edwards, surgeon at the settlement on Red River; together with a description of the specimens collected by Mr. Edwards and by Mr. Holdsworth, surgeon at York Fort,' is the title of a paper in which the water and depth of the lake is described. 'The coast on the eastern side, until you arrive at the Straits is low and sandy, but numerous rocks lie concealed at a little distance from the land. In the Strait the coasts on both sides are bold and rocky.' Two specimens from this lake are described, one a coarse-grained granite from an island north of Bloodvein River and the other 'a grayish fine-grained rock consisting of quartz and mica with some carbonate of lime from the west side of the lake near Buffalo Island.'

(Trans. Geol. Soc., 1st Series, vol. v., London, 1821, pp. 606-607.)

Gabriel Franchere, 1814.

In June, 1814, Gabriel Franchere on his way from the Columbia River, crossed Lake Winnipeg from the Saskatchewan to the Winnipeg

River. A short description is given of the general character of the lake.

(Narrative of a voyage to the North-west Coast of America, in the years 1811, 1812, 1813 and 1814 by Gabriel Franchere, English Edition 12 mo., New York, 1854, pp. 329-330.)

Franklin and Richardson. 1819–1822.

Captain (afterward Sir John) Franklin and Dr. (afterward Sir John) Richardson, travelled through the northern portion of Lake Winnipeg, from October 7th to 9th, 1819. On the return journey they reached Norway House on July 4th, 1822, on their way back to York Factory. Brief notes are given in his narrative describing the north shore and the limestone of the west shore, north of the Saskatchewan River.

(Franklin's Journey to the Polar Sea, 4to, 1823.)

Franklin, 1825–1827.

In February, 1825, Capt. John Franklin, with Dr. Richardson, Lieut. Back, Mr. Kendall and Mr. Drummond embarked at Liverpool for New York. Thence they passed westward to Fort William, and proceeded by the old north-west route to Cumberland House and west to Great Slave Lake. On their way east in the summer of 1827, they went from Cumberland to Norway House by the north end of the lake, and thence down the lake to Fort Alexander, from which place they proceeded to Montreal by the Ottawa River route. In passing Ottawa, Franklin laid the corner stone of the Rideau Canal Locks, in August, 1827.

In Appendix I. to Franklin's Narrative, Dr. Richardson gives an account of the limestone of Lake Winnipeg and the Saskatchewan River. He first gives its colour, structure, fracture and other general characters. He then enumerates the fossil forms found in the exposures at the first and second rocky points. On pages 54-57 he says:—'In the flat limestone strata near its foot, [Pasquia Hills] there are salt springs, from which the Indians sometimes procure a considerable quantity of salt by boiling, and there are several sulphureous springs within the formation.' * * 'The line of contact of the limestone with primitive rocks of Lake Winnipeg is covered with water; but at the Dog's Head, and near the north end of Beaver Lake, they are exposed within less than a mile of each other. To the southward of the Dog's Head, in Lake Winnipeg and a few other quarters, some schistose rocks, belonging to the transition series, are interposed between the two formations.'

A little farther on he states that the limestone of Lake Winnipeg is probably of the same age as that on Elk and Slave rivers, but that it differs in that it contains little or no petroleum.

(Narrative of a Second Expedition to the shores of the Polar Sea in 1825, 1826 and 1827, by John Franklin, Capt. &c. Appendix I. by Dr. John Richardson.)

In the maps of Lake Winnipeg accompanying this narrative, gneiss and greywacké is marked south of the narrows on the east side of the lake, while north of this, limestone is marked on the west shore.

Major Long, 1823.

The expedition under the command of Major Long, sent out by the United States Government in 1823 to determine the position of the International boundary at the Red River, proceeded down to Lake Winnipeg, after having accomplished their mission. The return journey was made up the Winnipeg River and through the Lake of the Woods eastward to Lake Superior. Mr. W. H. Keating, the geologist to the expedition, in his narrative notes the presence of primitive rocks on the Winnipeg River. He also adds :—'It appears probable from all the information which we have collected, that the whole of the eastern shore of Lake Winnepeek, is occupied by a primitive formation while the western is composed of secondary, and these probably limestone, rocks. This accounts for the fact that the prairies are limited to the east by that lake, while they extend as far north as the Saskatchewan and to a considerable distance up that stream. It appears to us by no means improbable that the excavation of this lake was occasioned by the earlier decomposition of the strata at the junction of the two formations.'

(Narrative of an Expedition to the source of the St. Peters River, compiled by W. H. Keating, A.M., &c., London, 1825.)

J. J. Bigsby.

Dr. John Bigsby in an article in the American Journal of Science, vol. VIII, 1824, pp. 60-88 mentions the limestones of Lake Winnipeg and Cedar Lake as probably of the age of the mountain limestone of the Carboniferous of Europe. He also mentions finding several fossils in the loose rocks of the Lake of the Woods.

Capt. Back, 1833–1835.

On the 17th of February, 1833, Captain Back accompanied by Mr. Richard King, sailed from Liverpool for New York, whence he pro-

ceeded to Montreal. Here he embarked in canoes, ascended the Ottawa, crossed lakes Huron and Superior and arrived at Fort William May 20th. From here he proceeded to Fort Alexander at the mouth of Winnipeg River, where he arrived on June 6th. He then traversed Lake Winnipeg to Norway House, from which place he crossed to the Saskatchewan and Cumberland House, and proceeded via Isle à la Crosse to Great Slave Lake. In the summer of 1835 he retraced his way through Lake Winnipeg and back to Montreal. On page 52 of his narrative, Back mentions that the east side of Lake Winnipeg is composed of smoothed and rounded granitic rocks of little altitude.

He speaks of ridges of sand and of the water rising in the lake. On page 60 he speaks of laminated clays at the north end of the lake, west of which are limestone rocks. In appendix IV., W. H. Fitton, naturalist to the expedition, quotes a letter from Mr. Stokes, concerning the *Orthocerata* found by Dr. Richardson and Capt. Back on Lake Winnipeg, comparing them with those described by Bigsby from Lake Huron. 'There is also one specimen which though not in good preservation, is doubtless a *Catenipora* or chain coral, a genus characteristic of the older transition limestones, in which beds also, *Orthocerata* are common.'

(Narrative of the Arctic Land Expedition &c., in the years 1833, 1834 and 1835 by Capt. Back, R. N. 8vo. London, 1836.)

Sir John Richardson, 1848.

On the 10th of April, 1848, Sir John Richardson and Mr. John Rae landed at New York, and proceeded to Montreal by Lake Champlain and thence by steamer through the lakes to Sault Ste. Marie, which they reached on April 29th. Here they took canoes for the remainder of the journey, passing through Lake Winnipeg the first week in June on their way to the Mackenzie River. In August, 1848, he again traversed Lake Winnipeg, calling at Norway House, and then travelling along the east shore of the lake. On pages 62-70 of his account he says:—'When we descended to Lake Winnipeg we came upon epidotic slates, conglomerates, sandstones and trap rocks, similar to those which occur on the northern acclivity of the Lake Superior basin; and after passing the straits of Lake Winnipeg, we have the granite rocks on the east shore, and Silurian rocks (chiefly birds-eye limestone) on the west and north, the basin of the lake being mostly excavated in the limestone. The two formations approach nearest to each other at the straits in question, where the limestone, sandstone, epidotic slates, green quartz rock, greenstone, gneiss and granite, occur in the close neighbourhood of each other.'

He then goes on to give the general character of the coast line and the mode of formation of bars and marshes around the shore. 'Considerable sheets of water are also cut off on the north-west side of the lake, where the birds-eye limestone forms the whole of the coast.'

He also mentions the influence the ice has in shoving up boulders on the shore. In Appendix No. I, he also refers to the physical features of the Winnipeg valley.

(Arctic Searching Expedition, &c. by Sir John Richardson, London, 1851, New York, 1854.)

D. D. Owen, 1848.

In the summer of 1848, David Dale Owen, while making a geological survey of Wisconsin, Iowa and Minnesota, for the United States government, descended the Red River to Lake Winnipeg and ascended the Winnipeg River to Lake of the Woods and thence to Lake Superior. He describes the character of the country around Upper Fort Garry (or Winnipeg) and the rock exposures at Lower Fort Garry, giving a list of fossils and analyses of two specimens of the rock. The beds are stated to be of the same age as the Upper Magnesian limestone of Wisconsin. He also describes the exposures on Lake Winnipeg, east of Red River at Poplar Point, and in a small bay near Big Swamp Point.

(Report of a Geological Survey of Wisconsin, Iowa and Minnesota, by David Dale Owen, United States Geologist, Philadelphia, 1852.)

Red River Exploring Expedition, 1857–58.

The expedition to explore the country between Lake Superior and Red River was placed under the command of Geo. Gladman with S. J. Dawson, surveyor; and Prof. H. Y. Hind, geologist. The parties started out during July, 1857, and pushed through to Fort Garry. The first report for 1858 contains letters descriptive of the country between Lake Superior and Red River, and in it Prof. Hind outlines a report on the country.

In the spring of 1858 the expedition was divided under the direction of S. J. Dawson and Prof. Hind, and the final reports form Appendix No. 4 to the Seventeenth volume of the Journals of the Legislative Assembly of the province of Canada, Session 1859. The report by S. J. Dawson contains a short description of the country and large maps and profiles. That by Prof. Hind deals more fully with the geology of the Lake Winnipeg basin than any previous one, and some of his notes and descriptions are quoted in the body of the present report.

S. H. SCUDDER, 1860.

In 1860, Mr. S. H. Scudder made a canoe trip from Fort Garry to The Pas on the Saskatchewan River. He described the *Orthoptera* collected by him, in the Canadian Naturalist, vol. VII., 1862 (pp. 283-288). He does not there make any notes on the geology. Subsequently he published an account dealing more especially with the incidents of the journey, and in this are a few references to the character of the coast on the west side to the mouth of the Saskatchewan River.

(The Winnipeg Country, or roughing it with an eclipse party, by a Rochester fellow. Boston : Cupples Upham & Company. 1886. 8 vo.)

A. R. C. SELWYN, 1872–73.

In the summer of 1872, Dr. A. R. C. Selwyn descended the Winnipeg River and coasted the south east shore of Lake Winnipeg to the mouth of Red River. The following summer he traversed the lake from the mouth of Saskatchewan River to the Red River. His reports refer to the superficial deposits of the south-east shore, and he also notes the presence of the limestone on the west side.

(Reports of Progress, Geol. Surv. Can., 1872–73 and 1873–74.)

R. BELL, 1874 and 1878.

In 1874 Dr. R. Bell descended the Little Saskatchewan River from Lake Manitoba and followed the shore to the mouth of Red River. He gives a short acccunt of the limestone cliffs as far as Dog Head.

Returning from Hudson Bay in 1878 he gives a short account of the character of the Laurentian rocks of the east shore with lists of strikes of the gneisses and direction of the glacial striæ. An uncoloured map of Lake Winnipeg is published with this report.

(Reports of Progress, Geol. Surv. Can., 1874–75 and 1877–78.)

A. S. COCHRANE, 1882.

In 1882 Mr. A. S. Cochrane made track-surveys of Berens River to above Family Lake, Pigeon River for fifteen miles of its course, Big Black River for eighty-two miles from its mouth and Poplar River from a portage from Big Black River to its mouth. He also made a sketch survey from Norway House to Grand Rapids.

(Report of Progress, Geol. Surv. Can., 1880–82 Summary, pp. 16-17.)

T. C. WESTON, 1884.

A large collection of fossils was made by Mr. Weston from the rocks of the west shore from Cat Head south to the Red River.

(Annual Report, Geol. Surv. Can., vol. I, (N. S.), 1885, p. 26A.)

A. P. LOW, 1886.

In 1886, Mr. A. P. Low crossed Lake Winnipeg from Red River to Berens River and ascended the latter to a portage to the head-waters of the Severn River. His observations are confined to the valley of the Berens River and to that of the Severn.

(Annual Report, Geol. Surv. Can., vol. II, (N. S.), 1886, part F.)

F. W. WILKINS, 1886.

In the summer of 1886, F. W. Wilkins under instructions from the Dominion Lands Branch of the Department of the Interior made a micrometer survey of the shore of Lake Winnipeg. In his account of this work he gives a running description of the lake and the adjoining country.

(Department of the Interior, Report for 1886, part II.)

F. D. Adams, Photo, 1889.

INTERSTRATIFIED GNEISS AND LIMESTONE, RIVIÈRE DU LOUP PORTAGE, NEAR MATTAWIN RIVER, QUE.

GEOLOGICAL SURVEY OF CANADA
G. M. DAWSON, C.M.G., LL.D., F.R.S., Director

REPORT

ON THE

GEOLOGY OF THE THREE RIVERS MAP-SHEET

OR

NORTH-WESTERN SHEET

OF THE

'EASTERN TOWNSHIPS'

MAP

QUEBEC

BY

R. W. ELLS, LL.D., F.R.S.C.

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST
EXCELLENT MAJESTY
1900

707

To G. M. Dawson, C.M.G., LL.D., F.R.S.,

Director, Geological Survey of Canada.

Sir,—I beg to submit herewith a report on the Geology of the area comprised in the north-west quarter-sheet of the 'Eastern Townships' map, or Three Rivers Sheet, of the province of Quebec. The area lies chiefly to the north of the St. Lawrence River, and has been surveyed in part by several members of the staff of the Geological Survey, at various times since 1868. The final report has, however, owing to various reasons, been delayed up to the present.

I am, Sir,

Your obedient servant,

R. W. ELLS.

Ottawa, December, 1898.

NOTE.—*All the bearings mentioned in this Report are referred to the true meridian.*

REPORT

ON THE

GEOLOGY OF THE THREE RIVERS MAP-SHEET

OR

NORTH-WESTERN SHEET

OF THE

'EASTERN TOWNSHIPS' MAP

QUEBEC.

By R. W. ELLS.

The present report includes the result of work done by several members of the Geological Survey staff. It refers to the area comprised in the north-west quarter-sheet of the 'Eastern Townships' map, known as the 'Three Rivers Sheet.' It must be explained, however, that this sheet, completing its series of four, does not comprise any part of the 'Eastern Townships' of Quebec, properly so-called.

The projection of this series of map-sheets was laid down over thirty years ago by the late Robert Barlow, who for more than a quarter of a century was the chief draughtsman to the Geological Survey. Although first engraved in 1868, important changes of opinion as to the interpretation of several geological problems met with in the area to the east of the St. Lawrence River, interfered with its official publication as a geological map for nearly twenty years, and the first map in the series, known in the catalogue as the 'Sherbrooke Sheet,' only appeared in 1886. This was followed in 1887-88 by the 'Quebec Sheet,' which completed the eastern half of the series. In the report for 1894 the south-west or 'Montreal Sheet' appeared, and in 1895 a portion of the sheet under consideration, or 'Three Rivers Sheet,' was published in connection with a special report by

Former publications.

Dr. F. D. Adams on the anorthosite areas situated to the north-west of Montreal. In the meantime, new surveys and explorations had accumulated in such amount as to render it necessary to re-engrave more than half the area of the sheet.

Earlier explorations in the district.

Geological explorations have been carried on at different times in this district since 1852. The results of the examinations for that year appeared in the Report of the Geological Survey for 1852-53, and subsequently, in condensed form, in the Geology of Canada, 1863. These results, however, related merely to the distribution and delineation of the Palæozoic formations which lie to the north of the River St. Lawrence, and in its more immediate vicinity, since, prior to the publication of the volume referred to for 1863, but little attempt was made to mark the distribution of the several members of the crystalline rocks in this district.

Mr. James Richardson.

In connection with the earlier work in this field, may be mentioned that of Mr. James Richardson, one of the first explorers on the staff; who, in 1852, made a series of paced surveys in the district along the lower portion of the St. Maurice River, and, farther west, along L'Assomption and Lac Ouareau rivers, as also in the vicinity of Joliette (then called the village of Industry), Kildare and along the Chicot River.

Sir W. E. Logan.

In the same year, Sir W. E. Logan also made a series of paced surveys in the area along the lower part of the Batiscan River, as well as in the vicinity of the St. Maurice, near the town of Three Rivers. This work of Richardson and Logan was largely undertaken to determine the boundaries of the several formations of the sedimentary rocks from the Potsdam sandstone to the Lorraine shales. All the divisions of the Palæozoic series between these two are apparently developed in the flat country bordering on the St. Lawrence, between Montreal and Quebec, before reaching the higher ground occupied by the gneissic and granitic rocks.

Mr. James Lowe.

In 1868, exploratory work was again taken up by Mr. James Lowe, in the northern portion of the area. In that year Mr. Lowe made a traverse from the upper part of the Rouge River to the head-waters of the Mattawin. In the following year, this was supplemented by a survey of the Brassard road, which leads from the village of St. Jean de Matha, in the county of Joliette, to the village of St. Michel des Saints on the upper part of the Mattawin, and, continuing his survey, he carried an exploratory line to the head-waters of the Rivière du Post, or Clear Lake River, reaching the northern limit of the map-sheet.

Further to the north, Mr. A. Webster made a section of the rocks along what is known as the Arcand-Temple line, which leaves the St. Maurice River at a distance of about seventy miles in a direct line above the mouth of the Mattawin, and extends south-west to Lake Atikomah, a distance of thirty miles. The continuation of this line of section was made east of the St. Maurice for a distance of ten miles. Mr. A. Webster.

In 1870, Mr. James Richardson, still farther north, carried an exploratory survey from the Mistassini River to the head of the Gatineau River, and descended the latter to the mouth of the Desert, which is about ninety miles north of the city of Ottawa. In this traverse the upper portion of the St. Maurice was followed to the height-of-land at the head of the Gatineau. These two lines of exploration, though situated to the north of the present map-sheet, are of importance as affording much information relative to the geological structure of the area as the height-of-land is approached, since they enable us to carry the lines observed in the northern portion of our sheet, northward, almost to the watershed between the St. Lawrence waters and those flowing into James Bay. On this latter exploration by Richardson the rock exposures are comparatively few, as is indeed the case throughout much of this northern area, owing to the fact that most of the surface of the country in this direction is comparatively level and is covered to a great extent with sand and gravel drift. The rocks seen throughout are, for the most part, gneisses of the type usually found in the district north of the Ottawa, and the same may be said of those found on the line of section made by Mr. Webster, where the gneiss is grayish and hornblendic, or reddish, and sometimes garnetiferous, resembling the prevalent gneisses of the St. Lawrence and lower Ottawa districts. They are thus identified with those included in the Grenville series, rather than with those belonging to what has been styled the Fundamental Gneiss. Mr. James Richardson. Country about the height-of-land.

Throughout these more northerly lines of exploration a series of well-defined anticlines is seen. The strike is generally to the north or north-east and the dip changes in several places from east to west. The angles of inclination are generally low. Anticlinal structure.

In 1870, Mr. McOuat was sent to carry out a series of paced surveys in the area to the north of the St. Lawrence. He spent several months in the lower part of the Batiscan district and farther west, in the area along the Rivière du Loup (en haut). In 1871, and in the following year Mr. A. Webster made a number of paced surveys of Mr. W. McOuat.

roads in the district comprising L'Achigan, Joliette and St. Jean de Matha, and also both to the east and west of Three Rivers.

Mr. L.R. Ord. Still later, in 1879 and 1880, Mr. L. R. Ord carried on somewhat extensive explorations and made surveys with the micrometer telescope and by pacing, in the area lying north and south of the Mattawin River, and completed an instrumental survey of that stream from St. Michel des Saints to its junction with the St. Maurice. In connection with his work, surveys were also made of many of the hitherto little known lakes and streams that are tributary to the Mattawin, both from the north and south, and our knowledge of the geology of the district was greatly increased.

Mr. R. G. McConnell. In 1880, Mr. R. G. McConnell made a number of road surveys in the district between St. Jean de Matha and the lower St. Maurice in the vicinity of Shawenegan. These extended north to the Wapizagonke and Piles lakes and south to Hunterstown on the Rivière du Loup. This work led to the delineation of a large area of reddish granite which occurs to the east of St. Gabriel de Brandon. He also located several masses of anorthosite rock that are important features in the geology of this district.

Dr. F. D. Adams. In 1887 and the three following years, Dr. F. D. Adams made close investigations over a considerable area in the western portion of the map-sheet, more especially in determining and outlining the extensive masses of anorthosite rock that are found to the north-east of the town of St. Jerome. In this connection, examinations were also made along a portion of the Mattawin and of a number of lakes and streams adjacent to it. The result of this work has already appeared on the map of the south-west portion of this area.

Mr. A.P. Low In 1891, Mr. A. P. Low examined and mapped the geology of that part of the map-sheet lying to the east of the St. Maurice River, in continuation of his work in the north-west portion of the 'Quebec Sheet' which adjoins it on the east. Most of the roads in this district were surveyed by his assistants.

Mr. N. J. Giroux. In 1891 and the two following years, Mr. N. J. Giroux endeavoured to complete the surveys in the area to the west of the St. Maurice, and made surveys, chiefly with the micrometer and odometer, of most of the streams, lakes and roads between the northern limit of the sheet and the southern limit of the crystalline rocks, in so far as this had not been already done.

Dr. R. W. Ells During the season of 1898 the writer of this report traversed much of the area along the Mattawin and as far north as the head-waters of

the Vermilion and Manouan rivers, almost reaching the west end of Webster's section of 1870. His examinations extended as far east as the St. Maurice at Grandes Piles, and included a portion of the area between Joliette, St. Gabriel de Brandon and the country to the north and east of that district.

It may be said, therefore, that the greater portion of the area included in this map-sheet, has been carefully examined. Much of this work has been done in places of which no maps existed ; and this feature has necessitated a large amount of topographical delineation. As a result of the compilation of the large amount of material which has thus been collected from so many sources, together with much that has been secured from the Crown Lands Department at Quebec, the accompanying map may be regarded as fairly complete in both topographical and geological details.

GENERAL CHARACTER AND TOPOGRAPHICAL FEATURES OF THE DISTRICT.

The area embraced in this map-sheet is about 6,912 square miles. Area. Of this a very large portion is unsettled and without means of communication except by canoe and portage routes. The line of the principal settlements extends north of the St. Lawrence River from twenty to thirty miles. Beyond this the only road open for vehicles to the Mattawin is that known as the Brassard road, which crosses the townships of Courcelles and Provost, and reaches the river in the township of Brassard. Here roads follow the Mattawin for about six miles Physical features. to the east and west of the village of St. Michel des Saints. Along the Brassard road are the villages of Ste. Emilie d'Energie and St. Zénon. This road is the only route by which this northern country can be reached by vehicle. Along the St. Maurice, above Grandes Piles, which is the northern terminus of a railway and important as the seat of the charcoal kilns of the Radnor Iron Company, communication is had with the upper part of the river to the settlement of La Tuque by several small steamers for a distance of about seventy-five miles. This area is almost untraversed by roads. The whole northern part of the district is therefore practically an unsettled wilderness, Game. abounding in large game, comprising bear, moose, caribou and deer. The beaver is yet plentiful along most of the rivers tributary to the Mattawin, and many of the lakes are well stocked with fish, pike being the most plentiful, though trout abounds in some of the inland lakes.

Exploration is, however, rendered comparatively easy by the number of streams and lakes which are everywhere found, though the portages are in many cases long and difficult.

St. Maurice River.

Of the many rivers that traverse this area north of the St. Lawrence River, the principal is the St. Maurice. This stream rises near the sources of the Ottawa, the Gatineau and Lièvre, and after a course of some three hundred miles empties into the St. Lawrence at the city of Three Rivers, nearly ten miles below Lake St. Peter. It has many tributaries, the chief of which on the west are the Mattawin and the Vermilion. The former of these traverses the entire north-western portion of the area under discussion, and takes its rise in lakes near the head-waters of the Rouge River. Several of its upper branches unite with the main stream not far from the village of St. Michel des Saints, whence the Mattawin becomes a large river, flowing with a generally slow current to the St. Maurice, but broken by many rapids and falls, necessitating about thirty portages. There are but few branches from the south and none of any length, as the height-of-land between this river and the St. Lawrence is rarely more than eight to ten miles distant.

Mattawin River.

Branches of the Mattawin from the north

From the north, however, in addition to the several branches that unite about fifteen miles above St. Michel village, there are several important tributaries, some of which are connected with large chains of lakes. Of these the principal are the Milieu, which enters the Mattawin about eight miles below the village of St. Michel, and the Post or Clear Lake River, which comes in two miles further north. The former of these takes its rise within a short distance of the upper waters of the Manouan, but from its very rough character along a considerable portion of its course is rarely used as a connecting route between the Mattawin and the northern waters. The Post takes its rise in Lake Clear, which is about six miles long by three miles in width, and is separated from the waters of the Vermilion by a sand and gravel ridge which has an elevation of about sixty feet, the portage between the two rivers being less than half a mile in length.

Canoe-routes.

From the west side of the Post, canoe-routes reach the Manouan waters also by means of the Hamel Brook, or by the Long Lake River, into Crooked Lake, whence Long Lake is reached by a portage 1,400 paces long. Long Lake has a length of nearly twelve miles, extending to the north-west, and from its head, Lake Traverse is reached by a portage of 750 paces. The portage from the head of Traverse Lake to Lake Sasikinegog on the Manouan waters is nearly a mile in length,

and the waters of the latter lake are at a level about eighty feet lower than those of Lake Traverse.

Lakes Sasikinegog and Traverse lie just to the north of the map-sheet, but were traversed in order to make our connections with the head of the Milieu. The first-named lake is large with a number of long arms, and the rocks around its shores belong to the upper series of gneiss and quartzite of the lower Ottawa district. The country along this route is otherwise uninteresting, the rock exposures being few, the hills densely wooded and the drift extensive.

Branches of Mattawin.

Descending the Mattawin from the mouth of the Post River, the principal streams from the north are the Cenelles, the Chienne, the Eagle and the Castor Noir. The Eagle and Chienne have large lakes near their sources, and from these routes extend across to lakes on the the Wessonneau, another branch of the St. Maurice that enters that river about thirty miles north of the Mattawin and furnishes a very good section across the upper portion of the area. All these streams and lakes have been traversed by the officers of the Geological Survey.

Rivers east of the St. Maurice.

On the east side of the St. Maurice there are also several branches, the principal of which, included in this area, is the Mekinac, which drains a chain of large lakes in the northern portion of the sheet. Farther east, the Batiscan is an important stream and flows across the eastern part of the area, entering the St. Lawrence about eighteen miles east of Three Rivers, while the River Ste. Anne which has been the scene of so many land-slides in recent years, has its mouth about four miles east of the mouth of the Batiscan. The lower portions of these rivers, for eight to twelve miles, flow through the great deposits of clay and sand that occupy the flat country north of the St. Lawrence, and afford but few rock exposures.

Rivers west of the St. Maurice.

Also north of the St. Lawrence and tributary to that river, but west of the St. Maurice, are several important streams. Among these are the Lac Ouareau, L'Assomption, Mastigouche, du Loup, Maskinongé and Yamachiche. The Shawenegan falls into the St. Maurice at the celebrated Shawenegan Falls, about eighteen miles from its mouth. All these streams have been traversed, together with the numerous chains of lakes along their courses.

Character of country west of the St. Lawrence.

While most of this area is hilly, and sometimes mountainous, a large part of it presents comparatively few rock exposures. Over much of the country north of the St. Lawrence, and in its more immediate vicinity, there is a wide-spread mantle of drift, consisting of clays,

sometimes overlain by sands and gravel, and sometimes interstratified with these. In places, as to the south and north of Joliette, these sand deposits take the form of dunes and the sand blows far and wide, so that vegetation over large areas is almost entirely destroyed. In the more northern portions of the area the sand and gravel are more generally distributed and the surface is comparatively level, showing but few rock outcrops, while the shores of the lakes and the banks of the rivers are composed of gravel and water-worn stones, forming terraces from fifty to one hundred and fifty feet in height. This generally level character of the country near the height-of-land, and for some miles on either side, has been pointed out by all the explorers in the district north of the St. Lawrence.

Terraces.

GEOLOGY.

Palæozoic formations.

As a result of the extensive drift deposits in the vicinity of the St. Lawrence, the delimitation of the several formations between that river and the edge of the crystalline rocks must always remain largely conjectural, and must depend upon the few widely scattered outcrops and upon the prolongation of the lines of strike between these, together with the estimated thickness of these formations where this can be determined. The Palæozoic formations as a rule are very nearly horizontal. They are, however, in places affected by local faults. In the area east of the St. Maurice, Mr. Low reports only four outcrops of the sedimentary formations between that river and the eastern limit of the area as shown on the map-sheet.

Area south of the St. Lawrence.

On the south side of the St. Lawrence, the area of the map-sheet is confined to the immediate vicinity of that river. This area is traversed by the lower portions of several rivers, among which are the Bécancour and the two branches of the Nicolet. On all these the rock exposures are good and the relations of the several formations can be well seen. This area is also traversed by several large faults, among which probably the most important is the great St. Lawrence and Champlain fault, which has been described in the report on the 'Montreal Sheet.'

In the subjoined table, the formations represented in the area of the Three Rivers map-sheet are arranged in descending order, separate

columns being given to the regions east and west of the St. Lawrence and Champlain fault.

List of formations.

System.	Formations. W. of Fault.	Formations. E. of Fault.	Character of Strata, etc. W. of Fault.	Character of Strata, etc. E. of Fault.
Silurian.	Medina.		Red shales and sandstones.	
Cambro-Silurian or Ordovician.	Lorraine.		Grayish shales and sandstones.	
	Utica.		Black bituminous shales	
	Trenton.	(Farnham)	Limestones.	Black graptolitic shales and black or dark impure limestones.
	Black River.		Limestones.	
	Chazy.		Chiefly limestone. Shale in lower part	
	Calciferous.		Magnesian limestones.	
	Potsdam.		Sandstones.	
Cambrian.		Sillery.		Red, and gray and green slates and greenish-gray sandstones.
Archæan.	Grenville.		Gneisses and limestones with granites and igneous rocks.	

Name Laurentian first used.

In the Report of the Geological Survey for 1851-52, the geological scale begins with the Metamorphic or gneissoid group. This is succeeded in ascending order, by the Potsdam sandstone. But in the report for 1852-53, this classification is changed by the use for the first time in the nomenclature of the Canadian Geological Survey, of the term Laurentian. The reason for the adoption of this term is given by Sir W. E. Logan on page 8 of that report, in which he says, 'The name which has been given in the previous reports to the rocks underlying the fossiliferous formations in this part of Canada, is the Metamorphic series, but inasmuch as this is applicable to any series of rocks in an altered condition, and might occasion confusion, it has been considered expedient to apply to them for the future, the more distinctive appellation of the Laurentian series, a name founded on that given by Mr. Garneau to the chain of hills which they compose.'

PALÆOZOIC FORMATIONS NORTH OF THE ST. LAWRENCE.

The Palæozoic formations found in the area situated to the north of the St. Lawrence, have already been briefly described in the early reports of Sir W. E. Logan, and the characters of the country, with the difficulties which exist in the attempt to decipher the structure of this district, have been pointed out. During the examinations by Mr. Giroux in 1891-2 of the area to the west of the St. Maurice River, careful attention was directed to finding outcrops of the Cambro-Silurian limestones in the district to the south of the crystalline rocks, and a number of outcrops, not noted by former observers, were located. From these places collections of fossils were made, which have been examined by Dr. H. M. Ami, by whom full lists of the species obtained have been prepared, and these accompany this report.

Fossils.

L'Assomption River.

Along L'Assomption River, near the town of Joliette, formerly known as the village of Industry, the best sections of the Cambro-Silurian strata are found. These are well exposed at intervals to a point about six miles above the town in a direct line, though the distance by the stream is much greater. South of Joliette the exposures also extend for several miles. The formations here developed, range from the Potsdam sandstone to the top of the Trenton. The town of Joliette lies just to the south of the southern limit of this map-sheet, being situated on the 'Montreal Sheet,' and a reference was made to the occurrence of Chazy and Trenton rocks near this place in the report on that area,* where the lists of fossils collected from this locality are given.

The Potsdam sandstones.

Supposed gold mine.

Ascending L'Assomption River the southern limit of the crystalline rocks is reached at a distance of about six and a half miles in a direct line from Joliette. The Potsdam sandstone formation appears along this part of the stream and is first seen at a place known as Bordeleau's mills, about four miles north of the town. The lowest member of the formation here, has a breadth of one mile and a half, and is a quartz conglomerate. The sandstone is usually a coarse whitish-gray rock, full of clear grains and small blebs of quartz, brownish and often rusty-weathering, and some of the beds are disturbed so that the dip could not be ascertained. The surface of the sandstone is often decomposed to a depth of four inches. Near this place a small quantity of disseminated pyrites has led to the supposition on the part of the settlers that gold exists in these rocks, and an opening has been made in consequence. The dip of the sandstone

*Annual Report, Geol. Surv. Can., vol. VII. (N.S.), 1894, pp.120-121 J, and 146-147 J.

along the rapids is at one point observed to be S. 70° E. < 12°. The last mile between the upper outcrop of the sandstone and conglomerate of this formation, and the first exposure of the gneiss, shows no ledges of rock, the banks of the stream being composed of sand and clay.

Calciferous limestone.

The exposed breadth of the Potsdam sandstone on this river is less than two miles. It is succeeded by the Calciferous limestone which appears at several points for a distance of two miles and a half in a direct line below Bordeleau Rapids. These are well exposed at several rapids along this portion of the river as at the foot of the Bordeleau, where they are almost in contact with the underlying sandstone, and represent the transition beds of the formation. They also appear at the Rapides des Sœurs and contain fossils in abundance, and lower down, are seen at the Rouleau and Beaudry Rapids. The dip of the limestones is to the south at low angles, from one to three degrees. The last exposures of this formation are about one mile and a half in a direct line above the town. The rock here contains small patches and vugs of pink calcite, and is rough and brown-weathering, with a concretionary aspect on the weathered surface. Below this nearly to the dam above the town, the banks are sandy and without exposures.

Chazy limestones.

About a fourth of a mile above the dam, are outcrops of gray calcareous sandy rock with clear grains of quartz, weathering brown. These are flat and show no fossils. They may represent the lower portion of the Chazy which is well developed in the upper or northern part of the town of Joliette, but of which the lower or shaly and sandy members are absent, unless they occupy that part of the river above the dam to the last recorded exposure of the Calciferous limestone.

Black River and Trenton.

In Joliette itself both the Chazy and Trenton limestones are seen. The strata here are affected by several faults, the dip sometimes being as high as sixty degrees. A small outcrop of the Black River limestone apparently comes in between the Chazy and Trenton proper. In these rocks several important quarries are established. The rocks of the latter formation extend down stream for several miles but are covered by the overlying clay deposits before the Utica beds appear.

Fossil localities.

To the west of this river, similar rocks are seen on the lower part of the Lac Ouareau River, but the beds on this stream lie beyond the limits of this map-sheet and therefore need only be referred to. To the east, in the direction of the St. Maurice, good rock exposures appear from beneath the clay and sand at several points. On the Chaloupe River where it is crossed by the road from Joliette to Ste. Elizabeth, and for some distance on either side of the road-crossing,

broad ledges of Trenton limestone, extending down into the upper part of the Black River, are seen. These are cut through by the stream, which here flows between rocky banks. The strata are in nearly horizontal positions. The fossils obtained from this place are as follows :—

Trenton of Chaloupe River.

Chaloupe River, near bridge on road to Ste. Elizabeth, Berthier Co.

Crinoidal fragments.
Pachydictya acuta, Hall, sp.
Plectambonites sericea, Sowerby.
Rafinesquina alternata, Conrad (Emmons).
Strophomena incurvata, Shepard (=*Streptorhynchus filitextum*, Hall of authors).
Strophomena, or *Rafinesquina*, sp. indt.
Orthis (*Dalmanella*) *testudinaria*, Dalman.
Rhynchotrema inæquivalvis, Castelnau, (=*Rhynchonella increbescens*, Hall, of authors.)
Zygospira recurvirostra, Hall.
Zygospira modesta, Say., or allied species.
Conularia Trentonensis, Hall.
Protowarthia cancellata, Hall, sp. (=*Bellerophon bilobatus*. Hall, of authors.)
Trochonema umbilicatum, Hall.
Asaphus platycephalus, Stokes.
Asaphus, sp. indt.
Pterygometopus callicephalus, Hall, (sp.)
Bumastus Trentonensis, Emmons. (=*Illænus Milleri*, Billings).
Leperditia, sp. indt., a very minute form.

Near Ste. Elizabeth.

Two miles south-east of the village of Ste. Elizabeth an outcrop of the Trenton is again seen, from which were obtained :—

Crinoidal fragments.
Pachydictya acuta, Hall, sp.
Prasopora, sp.
Several branching and frondose varieties of *Monticuliporidæ* requiring microscopic sections and examinations.
Orthis (*Dalmanella*) *testudinaria*, Dalman.
Orthis, *emacerata*, Hall ; cf. O. (*Dalmanella*) *testudinaria*.
Orthis (*Dinorthis*) *pectinella*, Conrad.
Orthis tricenaria, Conrad.
Platystrophia biforata, var. *lynx*, Eichwald.
Asaphus platycephalus, Stokes.

Chicot River.

At the crossing of the Chicot River near St. Cuthbert, and eight chains below the bridge, the following were obtained :—

Crinoidal fragments,
Monticuliporidæ, several branching forms.
Solenopora compacta, Billings, sp.
Plectambonites sericea, Sowerby, sp.
Orthis (*Dalmanella*) *testudinaria* Dalman.
Orthis (*Hebertella*) *occidentalis*, Hall.
Zygospira recurvirostra, Hall.
Asaphus, sp.
Calymmene senaria, Conrad.
Pterygometopus callicephalus, Hall, sp.
Remopleurides Canadensis, Billings, or a closely related species.

From Robillard's quarry, four miles north-east of the town of Joliette on the main road between this place and Ste. Elizabeth, the following were collected : Robillard's quarry.

Crinoidal fragments.
Rafinesquina alternata, Conrad, (Emmons.)
Strophomena incurvata, Shepard (=*Streptorhynchus filitextum*, Hall.)
Plectambonites sericea, Sowerby.
Orthis (Dalmanella) testudinaria, Dalman.
Orthis (Dalmanella) testudinaria emacerata, Hall.
Orthis (Dinorthis) pectinella Emmons, var. *semiovalis*, Hall.
Asaphus, sp.
Bumastus Trentonensis, Emmons, (=*Illænus Milleri*, Billings).

At Defond's quarry on the Chicot River, near St. Cuthbert. Defond's quarry.

Crinoidal and Cystidean fragments.
Glyptocystites Logani, Billings, showing both smooth and ornamented rhombiferous plates.
Pachydictya acuta, Hall.
Stictopora paupera, Ulrich.
Monticuliporidæ, several species.
Coscinium proavium Eichwald, as of Billings.
Arthronema ?, sp.
Rafinesquina alternata, Conrad, (Emmons.)
Orthis (Dalmanella) testudinaria) Dalman.
Platystrophia biforata, Schlothem, var. *lynx*, Eichwald.
Zygospira recurvirostra, Hall.
Asaphus, sp.

A second collection from the beds on the Chicot River, near the road crossing at St. Cuthbert, gave the following additional forms :— St. Cuthbert

Streptelasma corniculum, Hall.
Pachydictya acuta, Hall.
Ptilodictya maculata, Ulrich.
Batostoma Ottawaense, Foord, or allied species.
Solenopora compacta, Billings.
Leptæna (Plectambonites) sericea, Sowerby.
Strophomena, or *Rafinesquina*, sp. indt.
Strophomena incurvata, Shepard.
Rhynchotrema inæquivalvis, Castelnau (=*Rhynchonella increbescens*, Hall, and authors generally.)
Zygospira recurvirostra, Hall.

At Fafard's quarry, near St. Cuthbert village, the following were obtained :— Fafard's quarry.

Solenopora compacta, Billings.
Rafinesquina alternata, Conrad (Emmons).
Strophomena incurvata, Shepard.
Orthis (Dalmanella) testudinaria, Dalman.
Rhynchotrema inequivalvis, Castelnau.
Zygospira recurvirostra, Hall.

McGee's quarry.

From McGee's quarry, near St. Cuthbert village :—

Pachydictya acuta, Hall.
Batostoma Ottawaense, Foord, or allied species.
Lingula quadrata, Eichwald (as of Billings).
Leptæna (*Plectambonites*) *sericea*, Sowerby.
Strophomena (*Rafinesqaina*) *alternata*, Conrad, (Emmons).
Strophomena incurvata, Shepard.
Orthis (*Dalmanella*) *testudinaria*, Dalman.
Orthis (*Dinorthis*) *pectinella*, Conrad.
" " " var. *semiovalis*, Hall.
Parastrophia hemiplicata, Hall.
Calymmene, sp.
Asaphus, sp.

Of these last rocks, Dr. Ami remarks that the dark-gray semi-crystalline limestones in which the above species occur also hold masses and layers of dark-coloured chert, very similar to that found in the lower Trenton of Hull, and other places in the Ottawa Palæozoic basin.

Further east, at François Gagnon's quarry, near the village of St. Justin, in Maskinongé Co., the following Trenton species were collected :—

Gagnon's quarry, St. Justin.

Glyptocystites Logani, Billings.
Orbiculoidea lamellosa, Hall (*Discina Circe*, Billings).
Trematis? sp.
Leptæna (*Plectambonites*) *sericea*, Sowerby.
Strophomena (*Raflnesquina*) *alternata*, Conrad, (Emmons).
Orthis (*Dalmanella*) *testudinaria*, Dalman.
Zygospira recurvirostra, Hall.
Zygospira exigua, Hall.
Conularia Trentonensis, Hall.
Conularia, sp. nov.
Protowarthia cancellata, Hall (=*Bellerophon bilobatus*, Sowerby).
Hormotoma gracilis, Hall.
Ctenodonta, sp.
Endoceras proteiforme, Hall.
Trochoceras Halli, Foord, (=*Lituites undatus*, Hall).
Calymmene senaria, Conrad.
Ceraurus pleurexanthemus, Green.

Barrett's quarry.

From Barrett's quarry, three and a half miles north-west of St. Barthélmi, Berthier Co., the following were obtained, also of Trenton age :—

Climacograptus, sp.
Crinoidal fragments.
Lingula qaadrata, Eichwald (as of Billings).
(?=*Lingula Cincinnatiensis*, Hall and Whitfield).
Leptæna (*Plectambonites*) *sericea*, Sowerby.
Strophomena (*Rafinesquina*) *alternata*, Conrad (Emmons).
Strophomena (*Rafinesquina*) *deltoidea*, Conrad.
Orthis (*Dalmanella*) *testudinaria*, Dalman.

Zygospira deflecta, Hall.
Conularia Trentonensis, Hall.
Cyrtoceras, sp.
Orthoceras or *Endoceras*, sp.
Beyrichia, sp.
Asaphus platycephalus, Stokes (as of Billings).
" *megistos*, Locke.
Calymmene senaria, Conrad.
Trinucleus concentricus, Eaton.

Further east, near Ste. Ursule, in Maskinongé Co., the following species, which appear to shade upward into the Utica, were obtained :— Ste Ursule

Hyalostelia, sp.
Orthograptus quadrimucronatus, Hall.
Climacograptus, sp., cf. *C. bicornus*, Hall.
Crinoidal columns and other fragments.
Serpulites dissolutus, Billings.
Lingula Progne, Billings.
Lingula riciniformis, Hall.
Leptobolus, sp., cf. *L. lepis*, Hall.
Trematis terminalis, Emmons.
Strophomena, (*Rafinesquina?*) sp.
Leptæna (*Plectambonites*), sp.
Orthis (*Hebertella*), sp., cf. *H. sinuata*, Hall.
Zygospira, sp.
Zygospira exigua, Hall, sp.
Ctenodonta contracta, Salter.
Conularia Trentonensis, Hall.
Cyrtolites, sp., cf. *C. Dyeri*, Hall (=*Conradella Dyeri*).
Protowarthia cancellata, Hall (=*Bellerophon bilobatus*, Sowerby.)
Primitia, sp., or allied genus of *Ostracoda*.
Calymmene senaria, Conrad.
Harpes, sp., or *Harpina*, sp.
Triarthrus sp., small form resembling *T. Fischeri*, Billings, or young individual of *T. Becki*, Green.

From the Dalles of the Yamachiche River, two miles east of the village of St. Barnabé, in a dark-gray semi-crystalline limestone, the following were obtained :— Yamachiche River.

Pachydictya acuta, Hall.
Monticuliporidæ, several forms.
Lingula, sp. indt.
Leptæna (*Plectambonites*) *sericea*, Sowerby.
Strophomena (*Rafinesquina*) *alternata*, Conrad (Emmons).
Strophomena incurvata, Shepard.
Orthis (Plectorthis) plicatella, Conrad.
Orthis (Dalmanella) testudinaria, Dalman.
Rhynchotrema inæquivalvis, Castelnau.
Platystrophia biforata, Schlotheim, var. *lynx*, Eichwald.
Conularia Trentonensis, Hall.
Pterygometopus callicephalus, Green.
Encrinurus punctatus, or *E. multisegmentatus*, Portlock.
Asaphus, sp. indt.

The lists for the town of Joliette and for the localities in the vicinity have already appeared in the report on the 'Montreal sheet,' and need not be here repeated.

Rocks in the lower St. Maurice.

East of the Yamachiche to the St. Maurice no ledges of the Palæozoic formations appear. It is probable, however, that the different members of the system continue through beneath the clay covering with considerable regularity, since on the St. Maurice the Potsdam sandstone and the overlying Calciferous are exposed. On this river the first exposures of the Potsdam are seen about four miles below the Shawenegan Falls, or fourteen miles from the mouth of the river in a direct line. The lower beds of the formation here consist of conglomerates, as on L'Assomption River, the pebbles consisting for the most part of quartz, and the Calciferous limestones are exposed a short distance below this point. The beds are all nearly flat. Below this, to the mouth of the river the shores are composed largely of sand and clay, but Sir W. E. Logan, in 1852, recorded the presence of a somewhat broad exposure of the Utica shale at or near Pointe à la Hache, nearly opposite the old St. Maurice forges. This is about seven miles from the mouth of the river.

Outcrops east of the St. Maurice.

In the area between the St. Maurice River and the eastern limit of the map-sheet only four rock outcrops have been noted in the Palæozoic formations. Of these, two were discovered by Sir W. E. Logan, one of which is in the seigneury of Ste. Madeleine about four and a half miles east of the river and the other on the Riviere au Lard in the same seigneury. They are both in Trenton limestones. Of those noted by Mr. Low, one is on the Charest River, near its mouth, the other on the Rivière Ste. Anne, near the village of St. Casimir. Both of these also contained fossils of Trenton age.

PALÆOZOIC FORMATIONS SOUTH OF THE ST. LAWRENCE RIVER.

Area south of the St. Lawrence. Medina shales.

In the portion of the map south of the St Lawrence River, the same succession of formations does not appear. The red shales and sandstones, which have been regarded as of Medina age, are seen on the Bécancour and Nicolet rivers, and overlie the grey shales and sandstones of the Lorraine formation. The rocks of the latter formation have a breadth of about fourteen miles inland from the shore opposite the city of Three Rivers, and in their lower portion are affected by a series of faults and folds, the strata being tilted so that the dips are in places almost vertical, and these are brought directly against the red and green slates and sandstones of the Sillery formation which are

continuous from the vicinity of Point Levis, opposite the city of Quebec. The Utica and Trenton beds of the north shore are apparently cut out by the great St. Lawrence and Champlain fault, which extends from the city of Quebec to the foot of Lake Champlain. Fault.

The relations of the several formations in this direction have been briefly described, as they are seen on the Bécancour River, in the report for the year 1887. In the year 1895, however, Mr. Giroux carried on a series of surveys along the south side of the St. Lawrence from the St. Francis River to the village of Gentilly, extending south from the St. Lawrence about fifteen miles, in order to ascertain more definitely the extent of the Medina outliers and the relations of the Lorraine shales to the underlying formations.* Outcrops in the Bécancour and Nicolet rivers.

The area of the Medina outlier of red shales in the county of Nicolet, along the Nicolet and Bécancour rivers, has its apparent southern termination on the south-west branch of the former river, beyond which these peculiar rocks are not exposed in this direction. Thence it extends north-easterly, almost to the Gentilly River, a distance of twenty miles. On the Bécancour River, the breadth of the outlier is almost eight miles, while on the north-east branch of the Nicolet it is scarcely more than two miles. No fossils have been found in the strata of this formation, but as they rest upon the horizontal strata of the Lorraine near the St. Lawrence, and differ entirely from these in aspect, they have been assigned to the Silurian system as its lowest member.

Several isolated areas of these shales appear in a similar position on the Lorraine, in the flat country east of the St. Lawrence. Their outlines have been traced as closely as possible in this great drift-covered district, and they have been delineated on the 'Quebec' and 'Montreal' sheets already published. Medina outliers.

The thickness of the red shales of the Medina in this area has been proved in the borings made for natural gas several years ago. Thus, from a statement made by Mr. Obalski, mining engineer for the Province of Quebec, and reproduced by Dr. Selwyn in the Summary Report of the Geological Survey for 1887-88, it would seem that the thickness of the formation in the concession Beauséjour, which lies about three miles south-east of the village of St. Grégoire, is about 565 feet, at which depth the gray shales of the Lorraine were struck. The results of these borings is stated in the chapter on economic geology. Borings for gas.

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*Summary Report Geol. Surv. Can., 1895, pp. 70-71 A.

The underlying Lorraine shales are well exposed on the south side of the St. Lawrence, along the Bécancour and Nicolet rivers. On the former stream these rocks are apparently in contact with the rocks of the Sillery formation, but on the Nicolet a belt of black slates and limestones that represent the lower Trenton of Farnham to the south, and of the city of Quebec to the north, separates the gray shales from the red beds of the Sillery. Faults of considerable extent divide the Lorraine from the Trenton as also the latter from the Sillery. The Lorraine here carries an abundance of fossils at many points.

Lorraine shales.

The underlying Sillery beds present the usual features of red, green and black slates. These have been fully described in the earlier reports on the adjacent areas and need not be further alluded to here. The area of these rocks is confined to the extreme south-east corner of the map-sheet.

Sillery formation.

THE CRYSTALLINE ROCKS NORTH OF THE ST. LAWRENCE.

The geological features of a portion of the area embraced in the accompanying map-sheet, north of the St. Lawrence, have already been given in the report by Dr. F. D. Adams,* in connection with the distribution of the anorthosites, of which there are several areas in this part of the province, some of them of large size. In the classification of the gneisses there given, all are included under the head of Laurentian, and this is divided into the Fundamental gneiss and the upper or Grenville series of gneisses and limestones with quartzites. In the early reports on this district, the anorthosites were held to constitute the upper member of the Laurentian, and they were then regarded as altered sedimentary rocks. Later investigations on these rocks, have, however, shown them to be intrusive masses in the Grenville gneisses and limestones.

Report of Dr. Adams, 1895.

The investigations of Dr. Adams, Dr. A. E. Barlow and the writer, appear now to have shown that the Grenville series, and the Hastings series, developed to the south-west of the Ottawa River, are practically identical differing only in degree of metamorphism; and, taking the Hastings series as an intermediate term, the suggestion has also been advanced that both the Grenville and Hastings series are equivalent to the Huronian so largely developed still farther to the westward. This suggestion is, however, still the subject of nvestigation, and no rocks petrographically referable to the Huronian have been found in the district covered by the present report.

Hastings and Grenville series compared.

* Annual Report, Geol. Surv. Can., vol. VIII (N.S.) 1895, Part J.

In discussing the geology of this area, it may be stated that the great mass of the rocks seen pertain to the Grenville, rather than to the so-called Fundamental gneiss. The composition of the Grenville series, with its crystalline limestones and with rusty gneiss bands, very closely resembles that met with in the lower Ottawa district, but the calcareous members are much less widely developed. There are also large areas of anorthosite, red granite, augen-gneiss and masses of green pyroxenic diabase. With the latter are found in small quantity the same association of mica and apatite which is so marked a feature in the Ottawa and Rideau lakes districts, while with the limestones, serpentinous portions occur which sometimes hold small veins of chrysotile, (asbestus) similar to that seen in the mines at Templeton and along the Gatineau. Quartzite is also an important component of this series, and large areas of this rock, similar to that found along the Ottawa, are found associated with the gneiss as far north as the northern limit of the map-sheet.

Intrusive rocks.

Quartzite.

The definition of the so-called Fundamental gneiss, is, as a matter of fact, not always possible in this district; for, if the latter appears at all, it must be along the crests of some of the numerous anticlines that occur with a general course from south to north. These anticlines are, however, generally low, the rocks over a large area being inclined at low angles. The prevailing gneiss is the grayish and hornblendic variety, generally quartzose, and with frequent bands in which garnets are abundant.

Fundamental gneiss.

The explorations of which the results are combined in this report and the map accompanying it, are those of Mr. A. P. Low, in the area east of the St. Maurice, and those of Messrs. Adams, Giroux and McConnell in the country to the west of that river. Of these the work of Dr. Adams is already largely comprised in the report and map published in 1895, which includes that part of the general map-sheet from the west border, eastward in the Palæozoic area to a point about ten miles beyond the town of Joliette, and about eight miles east of the village of St. Gabriel de Brandon, in the crystalline area. Northward, on the western border, it includes Lake Cypress on the Mattawin waters, whence it extends eastward to Lac Sac à Commis, in the township of Decalonnes. It may perhaps be better described as having its northern limit on the parallel of 46° 30′ and the eastern on the meridian of 75° 15′.

Map accompanying Dr. Adams's report.

To the north of this boundary, the country is practically a wilderness. No settlers are found, with the exception of a few scattered along the course of the Brassard road which leads from St. Jean de

Matha to St. Michel des Saints, on the Mattawin and those along the banks of that river for a distance of six miles in either direction from that village.

Character of country on upper Mattawin River.

On many of the streams and lakes tributary to the Mattawin in its upper portion, rock exposures are few. Thus along the upper branches of the river, above the junction of the Cypress, which discharges Lake Cypress and meets the main stream about two miles and a half below the outlet of that lake, the country is largely drift-covered and the shores consist of banks of sand and gravel, with beaver meadows, so that rock exposures are rarely seen. Where they do occur. however, in this direction, the rocks are grayish and reddish-gray gneiss and the strike is generally a few degrees east of north.

Supposed gold mine near St. Michel des Saints.

On the Mattawin itself, above the village of St. Michel des Saints, the surface near the river is low and sandy and the stream very crooked. Two miles and a half up, however, there is a heavy and long rapid, caused by a ridge of gneiss which here crosses the river. The gneiss is reddish and grayish, often highly quartzose, and in places the layers abound in garnets. Small veins of quartz occur, and these sometimes carry small quantities of iron-pyrites which has been regarded by the settlers as indicating gold. Bands of black hornblende-gneiss are also seen, and the whole series is intersected by dykes of reddish and sometimes white granite or pegmatite. The strike of the rocks here is north-and south and the dip west.

Rocks around Cypress Lake.

Above this, nearly to the foot of Cypress Lake, the country adjacent to the river is low and the banks are of sand and gravel. Several heavy rapids occur in this distance, and these are sometimes caused by quantities of large boulders which in places obstruct the stream. Occasional ledges of grayish and garnetiferous gneiss with a general strike to the north-east are seen, and this course is maintained to the foot of the lake, where, at the outlet, gray gneiss has a strike N. 40° E. dip S. E. Around the shores of Cypress Lake, however, the gneiss, which is the gray and garnetiferous variety, has a constant dip of S. 30° W. or almost at right angles to the ledges along the river. Along the west shore of this lake the gray gneiss is associated with reddish gneiss and black hornblende-gneiss, the whole closely resembling the series found along the shores of Trembling Lake near the Rouge River. There are, however, no traces of crystalline limestone in this place, though the bands seen along the upper part of L'Assomption River, about four miles to the south-east of this, would, if they were continuous on their strike, appear here. The rusty gneiss which

accompanies the limestone is, however, found along the eastern shores. The continuous development of these limestone bands cannot, however, be counted upon in this area. The outcrops, where seen, are always very narrow and generally impure, and they are interrupted at many points, so that outcrops when appearing along the general strike of the gneiss are often at widely separated intervals. Their continuity is also frequently broken by the presence of intrusive masses of granite that cut across the general strike of the strata.

Limestones along L'Assomption River.

To the south and west of Cypress Lake there are high ranges of hills which separate the waters of this lake from those of Lac Ouareau. These hills resemble in character and outline the Trembling Mountain range. They are probably over 2000 feet above the waters of the lake, and may, like Trembling Mountain, represent the lower gneiss.

High ridges of Cypress Lake.

On several lakes to the south of this part of the Mattawin, notably along the west boundary of the township of Provost, the limestone again appears. It is seen along the shores of Lake Proteau or St. Grégoire, near the angle of Provost and Brassard, as also on Lakes St. Servais and Obompsawin to the south-east. On all these the limestone appears as a narrow band with rusty gneiss, the associated rocks being the usual grayish and dark garnetiferous variety. The general strike of the rocks on these lakes is north-west and south-east with a dip to the south-west and the limestone is very impure, with lumps of rusty gneiss and pyroxene. The rusty gneiss and limestone are both cut by dykes of white granite, while around the shores of these lakes, hills of reddish granite rise, which, in some cases at least, is newer than the gneiss with which it is associated.

Lakes in Provost Tp.

Crystalline limestone.

On the shores of Lake Trèfle, which is one of this chain in the township of Provost, though no limestone was noted, there are outcrops of the rusty gneiss. This is often very quartzose and in places is associated with quartzite. Garnets are sometimesabundant.

Garnetiferous gneisses.

The bands of limestone just mentioned, should, if continuous, cross the Mattawin near the south-west line of Brassard township. The shores along this part of the river are sandy and without exposures, so that their extension could not be traced, while the country to the north of this is almost inaccessible and shows nothing of value.

Further to the east, in the townships of Courcelles, Provost and Brassard, the limestones again appear. The rocks along the Brassard road to St. Michel have usually a low dip, but sufficient to indicate the presence of a series of light undulations. Along this road, north of

Limestone of the Brassard road.

the village of Ste. Emilie d'Energie, the rusty gneiss, which usually accompanies the limestone, appears, and there are scattered blocks of the limestone itself. It is therefore quite possible that a band of this calcareous rock which is concealed at intervals by the great mantle of drift, follows closely along the course of this road with a general north-westerly bearing. Approaching the village of St. Michel, near the east end of Lake Kaiakamak, the indications of this limestone band are more apparent, and large blocks appear along the road itself, with occasional ledges. The rusty and impure gneiss appears at the forks of the road east of the Mattawin River.

St. Michel des Saints.

About the village of St. Michel, the country is generally low and sand-covered, with hills of grayish and dark gneiss rising at a short distance. At the upper falls of the river, which are about one mile north of the church, large ledges of grayish and foliated gneissoid granite cross the stream. These are succeeded by grayish and garnetiferous gneiss, and along the road down the north side of the river, about a mile below the falls, a band of grayish crystalline limestone with rusty gneiss crosses the road. The dip here is south-west and the limestone band is exposed at intervals along the road for over three-quarters of a mile. It is presumably the extension of the band which is seen at intervals along the northern part of the Brassard road.

Limestone of Milieu River.

Further north, along the course of Milieu River, a branch of the Mattawin, limestone appears at several places in the vicinity of, though not directly on, the stream. Thus near the outlet of Lake Cutaway which is on the south-west side of the Milieu and about three miles north of the township of Brassard, there is a band of this rock about thirty feet wide, containing small quantities of plumbago, while the underlying rocks are grayish rusty and garnetiferous gneiss.

On the east side of the Milieu also, about three miles north of Perrault Creek, and near the line between the counties of Berthier and Maskinongé, a band of micaceous limestone is seen. This is in places serpentinous and mottled yellowish, apparently with chondrodite. A few scales of graphite also occur. This band can be traced for about ten chains, when the exposure is covered over with drift-sands and gravels. These two outcrops of limestone on the Milieu are about in the direction of those noted along the Mattawin and on the Brassard road.

Limestone of Post River.

Still further north, the calcareous members of this formation are seen along the upper part of Post River about two miles below the

outlet of Clear Lake, a small ledge of the limestone showing in the bed of the stream for a short distance. As the shores along this part of the river are composed largely of drift, the breadth of this band cannot be ascertained.

Crooked Lake

On Crooked Lake, also, which is reached by a portage from the lower part of Post River, by way of the Hamel Creek route, several outcrops of crystalline limestone are seen. These are along the eastern side of the east arm of the lake. The rock is generally somewhat impure, and the exposures are small. The dip is to the south-east at a low angle, but the rocks in the vicinity, and for most of the distance around the shores of the lake, are a reddish granitoid gneiss, in which the foliation is very often indistinct.

Grenville series.

The presence of these bands of limestone in this area indicates the extension of the upper Grenville gneisses and quartzite to the northern limit of the sheet.

AREA NORTH OF THE MATTAWIN.

Work north of the Mattawin River.

The examinations in this area were made principally along the Milieu, the Post and the connecting waters at the head of the Manouan, the Cenelles, Eagle, Chienne and Castor Noir, all tributaries of the Mattawin, and along the Wessonneau, which empties into the St. Maurice above the mouth of that river.

Garnetiferous gneisses.

On the Post and Milieu rivers, which were traversed to their sources, and the country explored for some miles further north, the rocks, where exposed, are generally grayish and sometimes a reddish-gray gneiss. These contain garnets in many places and the characteristic rusty quartzose gneiss of the Grenville series is a common feature. Masses of granite are frequent. This is generally foliated, but sometimes occurs as a massive rock.

Lake Clear.

The Post River takes its rise in Lake Clear. This is a beautiful sheet of water about six miles long by three in breadth in its widest part. Along the shores the rock exposures are few. Where seen the gneiss is grayish and quartzose with some rusty bands, and at one place on the east shore there is a large mass of highly quartzose grayish gneiss with a few broken dark bands, the strike of which is N. 5° to 30° W. with a west dip at a low angle. At the south end of the lake opposite the outlet, there is a low cliff of reddish gneiss, with black hornblende bands, and the dip is S. 75° W. $<$ 10° to 15°.

The portage from the north end of this lake, over a ridge of sand and gravel, reaches the Vermilion waters at the head of Lac des Pins

Rouges. This lake is narrow and extends north for about three miles, at which point Vermilion River flows out eastward to the St. Maurice. The lake is surrounded on all sides by sand, the hills are low and rock exposures are very rare. From the outlet of the Vermilion one can pass by a series of lake expansions connected by creeks to the west end of Lac des Sables, a further distance of about ten miles north. In all this stretch only two rock exposures were noted. These were at dams, and consisted of reddish-gray gneiss, the strike of which was north with a low west dip. Granite dykes intersected the gneiss The rest of the route showed no rocks other than boulders, and along the shores of Lac des Sables banks of sand and water-worn stones had an elevation of fifty to seventy feet above the surface of the lake. The surface of the country is general, low and sandy, and there are few elevations more than 100 feet above the general level. The timber is usually scrubby spruce and small red pine.

Headwaters of Vermilion River.

From Post River to the Milieu, two routes can be followed to Crooked Lake. One of these is by the Long Lake River which comes in from the west at about four miles below the outlet of Clear Lake the other by the Hamel Creek route which leaves the Post about five miles in a direct line from its junction with the Mattawin, though the distance is much more by stream owing to its many bends. There are a number of heavy portages by either route. Along the course of Long Lake River from the Post, the rocks are for the most part, where exposed, a reddish, coarse, foliated granite About midway there are large exposures of a reddish coarse augen-gneiss with a dip to the west of 85°. The rapids along this river are caused generally by great bouldery masses of the reddish foliated granite, while the banks of the stream are often occupied by drift. At the north end of Crooked Lake, there are great exposures of the coarse, reddish foliated granite, composed of red felspar, quartz and black mica, the foliation being nearly horizontal. The rocks along the west shore of the east arm of this lake are practically the same foliated granite, but along the east side, three outcrops of limestone already referred to come in. These cannot be connected and their continuity is probably affected by granitic masses. The strike of the foliation is almost always the same as the course of the lake. Boulders of reddish granite-gneiss are frequent and these with sand and gravel form the long point that divides the lake into long bays to the east and west

Canoe-routes from Post to Milieu rivers.

Reddish granites.

The shores of the west arm are mostly a coarse red foliated granite-gneiss, having a west dip at angles 10° to 15°. On the south shore of the arm, towards the north end, the dip changes to E. $< 15°$. Along

the portage to Long Lake, as well as along the greater portion of that lake, the rocks are very similar to those just described. They are mostly reddish, moderately coarse granite-gneiss and there is an apparent absence of the banded grayish and garnetiferous gneiss. In this respect the rocks are like those seen along the upper Ottawa at the Petewawa and opposite Pembroke on the north side of the river. But at the upper end of Long Lake after passing the narrows the rusty-weathering grayish mica-gneiss, with garnets, again appears with a dip of E. 5° to 10°. These mica-gneisses apparently continue across to the Sasikinegog Lake on the Manouan, though at the narrows of Lake Travers, which is at the head of the Long Lake River, the reddish granite-gneiss again appears in great blocks and also in ledges. Along the shores of the Sasikinegog Lake the gneiss is of the usual grayish type with black bands, and there are large areas of grayish quartzite, similar to that observed along the lower Ottawa in connection with the limestones of the Grenville series. Long Lake. Sasikinegog Lake.

The strike of the rocks along the shores of this lake is from north to N. 40° E. and the dip is sometimes to the east and sometimes west at low angles. The quartzite apparently overlies the grayish and hornblendic gneisses and there are also bands of the rusty gneiss. Several large areas of a dark-green, sometimes black diorite rock, with large crystals of hornblende, occur in the large south bay where the route to the Manouan takes off, which is by way of Pasquatezebe River and Lake. Headwaters o the Manouan.

The upper part of this river is for some miles the route followed to reach the head of the Milieu River on the way to the Mattawin. The stream is exceedingly crooked, flowing through a flat country with swamps to Lac Vaseux, from the upper part of which a portage of over a mile leads to Lac à la Tête which is near the head of this stream. Along this part of the route no ledges are seen, but large boulders of red granite-gneiss show on some of the points and islands. A portage of 450 yards leads to Lake B. which is apparently the head of the Manouan waters in this direction. Large masses, probably boulders, of grayish mica-gneiss are seen at intervals around the shores. Hills of 100 to 200 feet in height rise a short distance back from the shores, but these are all densely wooded so that no rock outcrops appear.

A portage of 500 paces over a low ridge leads from the Manouan waters to the head of the east branch of the Milieu. The first lake on this stream has low and swampy shores, but there are blocks of the gray garnetiferous and often rusty gneiss. On the next or Crooked Lake the ledges appear, and there is a heavy fall at the outlet over

grayish rusty gneiss which is cut by small and hard diabase dykes. This is associated with bands of the black hornblendic and garnetiferous gneiss along with masses of gray quartzite. From this point down to the lower end of Long Lake on this stream the shores are low and gravelly. The river is very difficult to traverse owing to the dense

Milieu River.

alder growth which almost entirely blocks the channel for miles. Boulders are frequent, and just before reaching Long Lake gray mica-gneiss appears with an east dip of ten degrees. From the foot of Long Lake where the reddish coarse granite-gneiss again comes in, the river for some miles is very rough. The rapids are frequent and often very heavy, the stream being in many places almost choked with great boulders of gneiss and granite. Occasional ledges of the grayish and reddish gneiss are seen, generally with a low east dip, and sometimes masses of reddish granite occur. For the last four miles before reaching the Mattawin the river runs between gravel banks and its course is very crooked. Occasional large blocks of reddish gneiss are seen. Along the lower part of the Milieu, both to the east and west, there are several deposits of mica associated with small quantities of apatite.

Mica deposits of Lake Cutaway.

These occur in pyroxenic rocks that traverse the grayish garnetiferous gneiss in the vicinity of Lake Cutaway already referred to. An attempt was made some years ago to work the mica deposits in this district, but owing to the shattered condition of many of the sheets and the distance from a market, the enterprise was abandoned.

From the association of these minerals in the rocks of this area and the general similarity in the character of the gneiss here, to that seen in the Buckingham mineral belt of the Ottawa, it would appear that these rocks in the Mattawin may safely be regarded as the equivalents of the upper Grenville gneiss and limestone. In the more immediate vicinity of the Mattawin, limestone occurs not far from the upper end of the Pine Lake expansion on the south side of the river, as well as on the north side. Other localities are on lot 12, R. II and lot 20, R. C. Brassard township. In the latter place the limestone is micaceous and is associated with serpentine which contains small threads of chrysotile.

Chrysotile of L'Assomption River.

On the upper portion of L'Assomption River along L'Assomption Lake there is a well-defined belt of this rock. It also has serpentinous bands and carries veins of chrysotile, some of which are half an inch in thickness. This limestone strikes along the course of the river about north-west, and can be traced for some miles. It does not however reach Cypress Lake, being possibly cut off by granite or by a thinning of the deposit, as is often the case.

East of Post River and about fifteen miles from its junction with the Mattawin, a portage leads across to the Cenelles River, which flows south and enters the Mattawin about fifteen miles below the Post. The Cenelles is only a small stream, but has several lakes along its upper part. The country along the stream is generally rolling, with sandy plains and hills of gneiss. This rock is often garnetiferous and has bands of quartz, but no trace of limestone was noticed by Mr. Ord in the whole distance, with the exception of a piece forming part of a boulder. The strike of the gneiss is a little west of north, and the dip generally west at a low angle. North of the Rapide Lacroix which is about four miles above the mouth of the Cenelles, limestone again appears. Of this locality Mr. Giroux says, "On a lake on Lacroix Creek and about two miles north of the Mattawin, highly quartzose grayish gneiss occurs with patches of hornblende, and near the outlet of this lake, which is at an elevation of 220 feet above the river, there is an exposure of impure limestone forming a bank about twenty feet high and resting on a whitish quartz rock which dips south-east at a low angle. Rusty gneiss also occurs. The limestone is cut by small dykes of white granite. About ten chains farther north, is another small outcrop of impure limestone, separated from the last by a band of gray garnetiferous gneiss which shows an anticlinal structure, the dips being S. 25° E. and N. 50° W. < 20°. The second outcrop of limestone dips S. 60° W. < 16° and rests on highly quartzose gneiss which can be traced for over half a mile in a northerly direction, to a small lake at the foot of which a ledge of limestone nine feet thick and two chains long, white and crystalline, dips N. 60° W. < 10° and rests on a brownish, much decomposed gneiss. The limestone at all these places is very impure, containing green pyroxene in grains and lumps distributed through the mass along with scales of brown mica."

Cenelles River

Crystalline limestone.

Along that part of the Mattawin between the upper falls, one mile below St. Michel village, and the mouth of the Cenelles, there is a general resemblance in the rocks to those which have already been described. The banks of the stream are low and sandy for a large portion of this distance and the rock outcrops are few. Rusty gneiss shows in a ledge on the south bank about a fourth of a mile above the mouth of the Milieu. The dip here is south-east < 25°. From the Milieu to the Post the shores are low and without exposures, but a short distance above the latter stream, ledges of gray gneiss with masses of pink felspar, occur in the river. The strike of this is too indistinct for determination.

The Mattawin below St. Michel.

From Post River to the head of the Ile de France, the shores are low and sometimes marshy. Ranges of hills, composed apparently of gray and reddish-gray gneiss, rise on either side, a short distance back from the river, but these are low and the surface generally is without marked elevations for some distance. A fourth of a mile below the head of the Ile de France, a short portage crosses over ledges of generally coarse granite, cut by dykes of a dark hornblende-diorite containing grains of magnetic iron. Several small rapids occur in the north channel past this island, caused generally by boulders of gneiss, and there are occasional ledges of a dark-gray gneiss in which the strike cannot be readily seen. Some of the bands are garnetiferous and all are of the Grenville type. The dip where visible is N. E. $<10°$.

Ile de France.

From the foot of the Ile de France to the mouth of the Red Canoe River, which enters from the north, several small outcrops of the grayish garnetiferous gneiss are seen, but the shores for the greater part of the distance are low and have sandy and bushy banks. These extend to the head of Rapide Lacroix, where the grayish quartzose gneiss, with garnetiferous bands crosses the river and extends to the lake on Lacroix Creek already referred to in the remarks on the limestones.

Garnetiferous gneiss. Lacroix Rapid.

Bottle River.

Below the mouth of the Lacroix to the mouth of Bottle River, which enters from the south side, the banks are low and bushy. Occasional low ledges of the ordinary gray gneiss cross the river, the strike being at one point N. W. and the dip N. E. $<10°$. Just below Bottle River the gneiss is flaggy and the dip changes to west $<10°$. These rocks are cut by dykes of reddish granite and there is apparently a low synclinal in this part of the section.

Descending the long stretch above the mouth of Cenelles River the banks are sandy and show no ledges. At Cenelles Rapids fine grained gray and black gneiss, with bands of reddish-gray, have a strike of N. 70° W. and a dip to the east, indicating an anticline in this part. Masses of red granite which is apparently a newer rock than the associated gneiss, appear above the rapid. The angle of dip of the gneiss varies from 4° to 20°. The rock is very quartzose and contains fine-grained bands which often have large crystals of felspar. At the foot of the rapids the dip is N. $<15°$ and the gneiss is affected by a couple of low undulations.

Cenelles Rapids.

At the Empty Barrel Rapids the portage is very rough, over great masses of reddish granite. Below this, past Green Island Rapids, the Cedars and the Cypress, to Burnt Island Rapids, the expos-

ures are few. Those seen are of gneiss, grayish and reddish-gray, and often highly quartzose. At the Cypress Rapids the strike is N. W. and the dip N. E. $<10°$. Just above the Burnt Island Rapids, a cliff of sand, covering a boulder-clay, is exposed for a height of seventy-five feet above the river. Near the head of the rapids a ledge of dark or black mica-gneiss crosses the river in nearly flat layers or with a dip to the S. W. $<5°$. Below this to the Ox Bow Rapids the shores are low and sandy with large boulders. Granites and gneiss.

The Ox Bow is overcome by a portage more than a mile in length which cuts across the head of the long bend. The first half-mile is over almost bare ledges of reddish-gray granite with black mica. This is foliated, and in places the layers are distorted after the fashion of a flow structure. There is a small muddy lake midway on this portage and the second half to the river shows no rocks other than large boulders of the foliated granite. Ox Bow portage.

Below this rapid the ledges are reddish-gray mica-gneiss, the strike is nearly east-and-west, and the dip to the north at an angle of five to ten degrees. A short distance below, the foliation in a red granite gneiss dips N. 20° E $<15°$, and thence to the Grand Price Rapids the same rocks continue and the dip is N.E. 8 to 15°.

At the head of the Grand Price the rocks are reddish-gray and dark gray gneiss, the dip changing to N. 70° E. $<15°$. The portage past this rapid is 1,200 paces long over a coarse reddish gneiss with much quartz. In places the rock is almost black from the abundance of the black mica. The dip is north two to four degrees, with low undulations. The rocks for some miles along this part of the river are thus affected. They are apparently a lower portion of the gray garnetiferous series which is so wide-spread along the upper portion of the river. At the end of the Grand Price portage the dip is N. E. $<20°$. Grand Price Rapids.

At the Little Price Rapids, the rock is a coarse reddish granitoid gneiss, overlain by the reddish-gray gneiss of the usual type. At the lower end of this portage which is about half a mile in length, the gneiss strikes N. 60° E., and dips N. 30° W. $<15°$. There is a large area of gray quartz near the lower end of the portage, but at the river the rock is a garnetiferous gneiss, with dark or black micaceous bands. These rocks are sometimes greatly twisted but the general dip is to the north at a low angle. All the gneiss is very quartzose in this part of the section.

From this down to the mouth of Rivière à la Chienne, the banks are low and sandy with occasional gneiss boulders. High hills rise on either side and all are densely wooded with a small second growth. Just below

3

Chien Rapids.

Arachie Rapids.

the mouth of Rivière à la Chienne, ledges of dark-gray mica-gneiss have a north-west dip at low angles. The rocks here, however, are often much twisted and the strikes vary greatly. At the upper end of the Chien Rapids the foliation in ledges of reddish-gray gneiss is very flat, and at the foot of the rapids the dip is west <10°. Along the portage past the Chien Rapids the reddish-gray gneiss is in low undulations, and at the lower end the dip again becomes reversed to the east. A little below this the gneiss becomes very quartzose and rusty and strikes N. 50° W., with a south-west dip <15°. Thence to the head of the Triplets which is a group of three small islets, there are several undulations with low angles, the dip at this last point being S. E. <10°. At the lower part of the Triplets, a hill of grayish gneiss rises on the north bank, from the edge of the river to a height of about 500 feet. This is about one mile above the head of the Arachie Rapids, where reddish and reddish-gray gneiss cross the stream with a strike of N. 70° W., and dip S. 20° W. <20°. These rocks are a good deal disturbed and are cut across by masses of red granite, the whole forming, for half a mile or more, a very rough part of the river.

From the mouth of Rivière à la Chienne, the explorations of Mr. Giroux extended north to the Wessonneau waters, which are along the northern margin of the map-sheet.

Rivière à la Chienne route.

At the mouth of Rivière à la Chienne and for some miles west, the country is covered with sandy drift, which forms a slightly rolling plain, extending to Lac à la Cache, or about five and a half miles north of the Mattawin. This feature is seen in ascending the stream, which runs in a flat narrow valley, bordered by small rounded hills, densely covered with small timber. Six miles up from the Mattawin are the High Falls with a pitch of ninety feet over a reddish gneiss filled with small grains of clear quartz, dipping apparently N. 70° E. < 14°. The banding is very indistinct and the foliation also disappears in places when the rock becomes a true hornblende-granite.

From Lac à la Cache the route to Lac à la Chienne is by the west branch and through a chain of small lakes. All along the route the prevailing rock is gneiss, grayish or pinkish and with black hornblende or biotite bands. The dips are generally E. <30°. A feature of the mountains in this area is pointed out by Mr. Giroux, who remarks that they are much more broken and less continuous than in the ranges farther to the south and south-west, and have often one perpendicular face from 150 to 300 feet in height, fronting on the lake or stream.

Lac à la Chienne is situated in a basin-shaped area, with high mountains along the east side and low hills to the west. From the head of the lake the country appears to be comparatively level but thickly wooded. The lake is celebrated for the size and excellence of the salmon trout which abound in its waters. The east shore of the lake is generally rocky, and the rounded ledges consist of coarse reddish gneiss, holding large crystals of white-weathering felspar. Similar rocks occur on the large island, and the dip here is north $<8°$ to $10°$. Lac à la Chienne.

The upper portion of Rivière à la Chienne enters this lake near the north-west angle. The stream in this upper part flows through alder swamps with banks of sand and gravel for about eight miles, when a portage-route takes off to Eagle Lake, which is at the head of Eagle River. Along this portage and the intervening lake, there are ledges of pinkish-gray gneiss, dip S. 20° W. $<20°$.

Eagle Lake is very irregularly shaped with large bays. Along the north shore the reddish gneiss is cut by dykes of white-weathering pegmatite; but the dip is difficult to determine as the rocks are low-lying and the inclination of the bands low. From the foot of the lake along the upper part of Eagle River, the rocks are highly felspathic, reddish gneiss, with bands and thick beds of black hornblende-gneiss. These reddish rocks generally weather rough from the presence of the felspar and quartz, and there is often very little mica in the rock. The quartz, which is so abundant in the gneiss along the Mattawin is much less abundant in the rocks of this area. Eagle Lake.

The rocks along the lower half of the Eagle consist for the most part of reddish granitoid gneiss, with a dip near the Mattawin of S. 20° W. $<30.°$ Ascending the river from its mouth, there is a portage of about one mile and a half to the foot of the first lake, to overcome the rapids and bad water along the lower portion of the stream. This portage turns off from the river at a small creek about midway on the route past the Arachie Rapids. Eagle River.

Along the shores of the lower lake on EagleRiver, there are cliffs of granite-gneiss composed of a yellowish quartz, red felspar and black mica. The rock is in places pyritous and foliated with a dip of S. 70° E. At the head of the lower lakes another portage leads past heavy falls and rapids to the second chain, over a ridge of foliated granite, the direction of which is the same as along the lower part of the stream. Along the shores of the upper chain of lakes the strike and dip change, and the latter is here S. 55° W. $<15°$. At the chute at the head of this chain of lakes, ledges of grayish and hornblende-gneiss, with garnetiferous bands, strike N. 40° W. and dip to the south-west,

and the same brownish-gray gneiss extends up the stream presumably to the head, showing in high cliffs with bold faces next the lake or river. The hills around the lakes and along the lower part of the river are high and apparently of granitic gneiss. While the gneiss along the route is generally quartzose and in some respects resembles that of the Grenville series, it apparently underlies the upper Grenville gneiss and represents one of the broad anticlinal folds seen along the middle portion of the Mattawin River.

Granite-gneiss

Following the upper part of Rivière à la Chienne for a further distance of about six miles above the portage into Eagle Lake, a portage is made into Sleigh Lake, one of the upper lakes at the head of the Pabelangnang River, a branch of the Vermilion. The portage from the Chienne waters into this lake is over a ridge of reddish granite, containing but little mica and hornblende. Sleigh Lake is about six miles long and varies from five chains to a mile in breadth. It is very irregular, with deep bays, and is surrounded by low hills of reddish-weathering granite-gneiss. At the south end of the lake the strike is N. 40° W., the dip S. 50° W. < 30°, but throughout much of the area the foliation is very indistinct, and the weathered surface is very rough. Large distinct bands of almost pure hornblende and also of red felspar are frequent in this rock, but the quartz is much less abundant than in the area further to the south. Similar rocks are seen along the shores of Lake Dorval, which is the next lake to the south-east, where the shores are strewn with boulders of granite-gneiss.

Sleigh Lake.

Lac à Baude.

The outlet of Lake Dorval, which empties into Lac à Baude, is about one mile and a half long, and runs through a low valley in which boulders are very numerous, and near the lower end hills of brown coarse hornblende-gneiss rise on either side.

Lac à Baude is nearly at the same elevation as Sleigh Lake. It shows but two rock exposures, of which one is near the end of the portage from the last lake, and the other near the north end of the lake where the portage leads off to Lake Wakaumekonke. Here there is a cliff about 150 feet high, the base of which consists of a very coarse granite. The rock is reddish and holds much magnetic iron in grains. This tarnishes to a purple. The reddish granite contains also the rather rare mineral allanite, over somewhat large areas, to the extent of thirty-five per cent of the mass. The allanite crystals are of unusually large size. The containing granite, which has the aspect of an eruptive mass, is overlain by bands of hornblende-gneiss which are separated by layers of reddish quartz and felspar rock. The gneiss dips here S. 70° E. < 35°, indicating a break or an anticlinal at this

place, as the prevailing dips hitherto in this area have been to the south-west.

Near the western end of this cliff a dyke of pegmatite, about five feet wide, carries numerous large crystals of mica. The quartz in the vicinity is almost black and the mica is a biotite.

Lake Wakaumekonke.

The portage to Lake Wakaumekonke is about two miles long. The lake is nearly circular with a circumference of about eight miles and is surrounded by low mountains. At the northern part, a cliff of broken and jointed red gneiss rises to a height of about eighty feet, and this rock is exposed for about two miles and a half along the north and west shores. The red gneiss is here followed by a thick band of hornblende rock, showing neither bedding nor foliation, which has a breadth of about one mile and a quarter, and is followed by the same reddish gneiss with a north-and-south strike. There are quantities of black iron sand along the shores of this lake and the red rock frequently holds bunches of iron ore.

The Wessonneau River and lakes.

The portage-route from this lake to the dam between Lakes Soucy and Steamboat Rock, which are on the Wessonneau River waters, is about three miles long and crosses six small lakes. The rocks along this route are gneiss, sometimes the black hornblendic variety, and sometimes reddish or gray. At the end of this portage, at the dam at the foot of Lake Soucy, there is a cliff of reddish-weathering granite-gneiss about 150 feet high, in which foliation is seen but no banding, and the rock holds large masses and irregular veins of coarse felspar. This gneiss extends along the east shore of Lake Steamboat Rock to within half a mile of the outlet of this lake, or to what is called the South Branch of the Wessonneau. From a point near the outlet of this lake a portage was made into Lac à la Pluie, a distance of nearly four miles in a straight line. At the height-of-land about 100 chains south-west of the latter lake, there are two small lakes, the more southern of which empties into Lake Steamboat Rock while the other discharges into Lac à la Pluie. On this last lake a hill of reddish felspathic gneiss shows a dip S. 70° E. $<28°$. The surface of the country on this traverse is covered with large boulders of reddish quartzose gneiss. The gneiss at the height of land holds thick bands which are black and micaceous, and lenticular patches as well as layers of coarsely crystalline felspar with bluish quartz. Around Lac à la Pluie there are many small sand-hills from ten to twelve feet high. The portage is swampy, and the stream flows through alder swamps and is not navigable. No rocks *in situ* are seen in this part of the route. From Lac à la Pluie the outlet down to the

Gneiss and granite.

middle branch of the Wessonneau, a distance of three and a fourth miles, was followed mostly along a portage-road, as the stream is unfit for canoes. On the route outcrops of a brown quartzose gneiss, interstratified with black micaceous layers and well banded, show a dip N. 70° W. < 12°, so that a low anticline apparently occurs at this place. The surface here is also covered largely with broad areas of sand with a profusion of large and small boulders of gneiss. From the forks of the branch with the Wessonneau to the St. Maurice, a distance of about twelve miles, the former is very rough and rapid. There are few rock exposures but the bed of the stream is full of boulders.

Rough part of river.

From the mouth of the Wessonneau to the Grande Anse, twelve miles lower down, the shores of the St. Maurice are largely of sand. At this latter point a portage-route of nine miles takes inland and strikes the Wessonneau River below the Wessonneau Lake. The portage shows a few outcrops of gneiss, reddish-gray, gray and black, but the dip could not be determined as the exposures are small. This portage reaches the Wessonneau River about half a mile east of a large bay, or near the intersection of a line between the seigneuries of Batiscan and Polette. Thence along the river and Lake Wessonneau to the portage near the head, but few rock exposures are seen. Brown micaceous gneiss near the foot of the lake dips S. 60° E. < 15°.

Portage from St. Maurice to Wessonneau River.

From the head of this lake to Lake Steamboat Rock the rocks met with are similar to those already described on the preceding page.

At the mouth of the Wessonneau River on this lake, reddish-brown gneiss outcrops at intervals along the shore as far as the Narrows. The rock has a general easterly dip at low angles, and varies greatly in composition, holding in places layers of hornblende-gneiss and in others patches of red, coarsely crystalline orthoclase felspar and bluish quartz. Where the latter mineral occurs the gneiss is highly quartzose and holds quantities of garnets. The shores of this lake are generally low and gravelly. The islands are also low with gravelly and bouldery beaches. The surrounding mountains are thickly wooded with small timber and the elevation of the lake is about 500 feet above the Mattawin at the mouth of the Castor Noir River.

Lake Steamboat Rock.

From the south-west end of this lake a portage of about a mile leads to the lake at the head of the East Branch of the stream just mentioned. This lake is two miles long and on the east has high hills of reddish-weathering granite-gneiss. About a mile south of this lake is another and along the connecting stream the brown gneiss dips S.

Route to Castor Noir River.

to S. 40° W. < 20° to 27°. This lake is about six miles north of the forks of the Castor Noir River, and along the east side are high bold and often bare hills apparently of the same reddish-weathering granite-gneiss.

The lower portion of the Castor Noir River is very rough and flows through a narrow valley, bounded on either side by high hills of grayish-weathering reddish-gray gneiss.

The lakes on the west branch of the Castor Noir are reached by a long portage from the Mattawin which takes off opposite the mouth of Antikiagamak River. There are several of these lakes of large size, but the rocks all along the route as well as around the shores of these lakes are similar in character to those described along the route to the Wessonneau, further north. The three principal lakes on this branch of the Castor Noir are Lakes Eveleen, Brown and Howe. Castor Noir River and lakes.

From Inman Lake, an expansion of the east branch of Gros Castor Noir River, a portage leads across to Howe Lake, which is near the head of the Ruisseau à Bastien. A ridge about 750 feet high, of brownish gneiss, lies between these two lakes and also extends along the eastern shore of the latter. From Howe Lake a route extends across to the head of Red Pine Brook. Along the Red Pine which is a very rough stream, flowing into the Mattawin a short distance below the mouth of the Eagle, the only rocks seen are the usual gneisses. These are mostly reddish-gray and hold bands of black hornblendic gneiss. The dip is obscure but at one point appears to be N. 50° W. < 8°. The valley of this stream is very rough and stony and almost bare of vegetation. Red Pine River.

The character of the rocks along the Mattawin from Cypress Lake to the mouth of the Eagle has already been stated. From the latter point to the mouth of the Antikiagamak River the Mattawin is rough and broken by heavy rapids and falls. In the whole distance from St. Michel to the mouth of the Antikiagamak there are no less than twenty-five of these rapids and chutes, many of which can, however, be descended by light canoes at a low stage of the water. The Mattawin River.

No limestones are seen along this portion of the stream till within a couple of miles of the Eagle Rapids, where numerous blocks of white and pink limestones show in the channel; but at two miles and a half below this rapid there is a band of limestone ten feet thick containing granules of green serpentine. The strike of this band is N. 50° W. and the dip is S. W. < 25°. Limestones below Eagle Rapids.

Along the Arachie Rapids of the Mattawin the rock is mostly granitic in character. In much of it there is a well-defined foliation,

but large portions are destitute of this feature. The general strike of the foliation is north-west and the dip is south-west. These generally weather a deep red. The lower end of the portage past this rapid is over reddish-gray and black gneiss, cut by large dykes of red coarse pegmatite. Thence to the end of the Red Pine portage, the rocks are granitic gneiss with reddish-gray bands, generally with a low dip to the south-west. At the foot of the Red Pine portage the grayish garnetiferous gneiss again appears, with a well-defined dip to the east of 10°. This rock continues along the river to the Galet Rapids where it is in broad flaggy ledges, with a dip, at the lower part, to the north-west. This rock is often a yellowish-gray mica-gneiss with quantities of garnets in some of the layers, and this feature continues down to the Bear Rapids.

Galet and Bear Rapids.

From this point a traverse was made by Mr. Giroux to the south of the river through a chain of lakes, and across to the head-waters of the Shawenegan River. This route passes through the Little and Big Bear Lakes, Lakes Prudent, Marcotte and Upper Crooked, to the head of the creek flowing into Lake Antikiagamak. The portages between these lakes are long and rough, with numerous boulders of reddish and gray gneiss. From the east end of Upper Crooked Lake, a series of portages with small lakes leads across to Lac des Iles which flows south into the Shawenegan. On all these lakes and portages the gneiss presents practically the same aspect as that seen along the route to the north of the Mattawin. The dip where noted is generally to the south-west at a low angle, but the exposures are not numerous. Along several of the lakes the gneiss forms bold cliffs, with the steep side towards the water. These are from 150 to 400 feet in height. Similar cliffs are seen along the west side of Lake Antikiagamak in its upper portion. The rock here also is a reddish-gray gneiss but the banding is not well defined. The shores of this lake are generally low and marshy and its surface is very little higher than the level of the river at the mouth of the creek which discharges it. A portage-road 3,500 paces long connects this lake with Lac des Iles on the head of the Shawenegan, and from the latter a creek connects with Lake Wapizagonke. The latter lake is about nine miles in length, but narrow. On the north side high gneiss cliffs extend for several miles along its lower or southern end, while to the west the shore rarely shows outcrops of rock. The country surrounding is densely wooded with pine. The gneiss along the lake lies in a nearly horizontal position, and the direction of the dip is obscure.

Route from the Mattawin to Shawenegan Lake.

Lake Antikiagamak.

Lake Wapizagonke.

To the west and south-west of this lake, are several large lakes, among which the principal is Lake Caribou. This and several others in

that chain discharge into the Shawenegan at the foot of Lake Wapizagonke. On another branch of this river is Shawenegan Lake and a group of smaller lakes, and around all these the same character of gneiss is seen. The prevailing dips in this area are to the south-west. Shawenegan Lake.

Further to the south, on the branches of Rivière du Loup, Lac à la Coureuse and others of this chain show similar gneiss; but on Lac à l'Eau Claire, which is several miles further south and on another branch of the du Loup, the rock is a reddish granite and syenite, which resembles that seen in the vicinity of St. Gabriel de Brandon, and that which forms the large granitic area between that place and Hunterstown. This syenite continues along the creek to the Rivière du Loup itself.

Returning to the Mattawin, the portage past the Little Bear Rapids is very rough, over a spur of a mountain, the rocks of which are reddish and gray quartzose gneiss holding garnets, the dip of which is south-west. Bands in this rock are dark-gray and gray with black mica. At the foot of the rapids the strike changes to north-east and the dip to north-west, and fifty paces lower on the river the dip becomes reversed to N. E. $< 5°$ to $10°$. A coarse reddish granite is intruded in this gneiss in broad sheets. At the Crapaud Rapids similar granites and gneiss are seen. The rock is very much disturbed. At the Little Grant Rapids the river falls about twenty feet over a grayish quartzose gneiss that lies nearly flat, and similar rocks extend down to the Grant Rapids, past which there is a portage nearly one mile in length. At the lower end of these rapids there is a bluff of reddish and gray gneiss in which the dip is N. 50° E. $< 50°$ and the gneiss is cut by masses of granite. Apparently there are several anticlines along this part of the stream, but the dips are for the most part low. Little Bear Rapids. Crapaud and Grant Rapids.

Similar gneisses extend down past the Bouleau Rapids, beyond which the shores are lower and the banks are generally sandy. The current becomes sluggish and no further obstructions occur to the mouth of the Antikiagamak River, where the Shawenegan Fishing Club has a house. Bouleau Rapids.

From the mouth of this creek to the head of the Little Cinq Rapids, where the portage leads off to the Grand Lac des Cinq and thence down to the Grandes Piles, the only rocks seen are grayish gneiss. The shores are generally low and sandy. From this point on the Mattawin to its entrance into the St. Maurice, the river is very rough and is but little travelled. There is an almost continuous succession of heavy rapids over ledges and large boulders. The gneiss is the usual grayish quartzose variety; the strike is generally nearly north-and-south. Portage from Mattawin River to Grand Lac des Cinq.

Several low undulations appear along this part of the river and near the mouth the dip is to the N. E. $< 20°$.

The portage from the head of the Little Cinq Rapids to Grand Lac des Cinq is over a ridge, and is rather more than three miles in length. The only rock-exposure shows a reddish-gray gneiss, of which the dip could not be ascertained. On the above lake, near the lower end, beyond the club-house, the shore is occupied by grayish gneiss with reddish-gray bands in nearly flat layers, or with a slight dip to the north. Several low undulations show along the shores of this lake, but the angle of the dip rarely exceeds five degrees. In the east bay the gneiss is occasionally coarse and reddish, with some black bands due to the prevalence of biotite.

The Cinq Lakes.

From this lake the usual canoe-route to the Grandes Piles is south to the head of the Cinq chain, through Lakes Dauphinais and Round. From the latter a portage of five-eighths of a mile leads to Lake Clear, which is at the head of the Pêche chain of lakes. Along this chain to the outlet in the St. Maurice, the rocks are all of the usual type of reddish-gray and gray gneiss, and some of the layers are filled with garnets. The dips are generally low and the bands are in shallow undulations, varying from south-west to north-east, with a general strike to the north-west.

Canoe-route to the Pêche chain of lakes.

Along the St. Maurice, which was traversed by Mr. A. P. Low in 1891 from the mouth of the Little Bostonnais to the junction with the St. Lawrence at the city of Three Rivers, the principal rocks seen are gneiss. From his notes along this part of the river it would appear that the upper Grenville gneisses are the prevailing rocks along the stream for the greater part of this distance. At the mouth of the Little Bostonnais, which is some miles north of the limit of the map-sheet, ledges of pinkish, fine-grained gneiss, with hornblende and mica layers, are well exposed, and these extend for some distance along that stream. At the chute a short distance above its junction with the St. Maurice, the rock is described as a medium-grained syenite-gneiss, highly felspathic, with green hornblende and a little quartz. The dip here is E. $< 45°$.

St. Maurice River, below Little Bostonnais River.

Below this point on the St. Maurice, similar rocks appear to prevail as far as the mouth of Rat River, holding bands of crystalline limestone at the big bend, about six miles below the mouth of the Little Bostonnais. The rock exposures along this portion of the river lie at some distance back from the shores, the river itself having banks of drift-sand and gravel for the most of this distance. Sandy terraces occur along both sides, the highest of which has an elevation of about

Terraces along river.

150 feet above the stream, but the most persistent of these is about sixty feet high, with several others at intermediate elevations. From the mouth of the Rat River to the township of Polette, which is on the northern limit of the map-sheet, the principal exposures are of fine-grained grayish mica-gneiss, weathering yellow from the decomposition of iron-pyrites and with bands of black hornblende-gneiss, in places containing garnets. The prevailing dip is N. 60° E. $<35°$ to 40°.

Crystalline limestones of Polette.

In the township of Polette, on lots 24 and 25, range II, there is a large exposure of crystalline limestone, some of which is a clear white and of fine quality. The breadth of this band at one place is said by Mr. Low to be four hundred yards. The strike is about N. 60° E. and the outcrop continues for three miles in this direction. The rock is generally coarsely crystalline and in places contains light-brown mica and green pyroxene, with small quantities of graphite. The mica is sometimes in crystals of large size and the dip of the deposit is to the south-east $<$ 8° to 10°. Thence to the mouth of the Mattawin, the rock exposures are usually of a fine-grained, yellowish, often rusty gneiss, with mica and hornblende, and these are cut by large dykes of coarse red pegmatite.

Limestone along the St. Maurice, below Mattawin River.

Below the Mattawin to near the mouth of the Mekinac River which is a tributary from the east, similar reddish and gray mica-gneiss and hornblende-gneiss occur. The dip is generally N. 50° to 60° E. at angles from 10° to 30°. At about two miles above the mouth of the Mekinac, similar rusty mica- and hornblende-gneiss holds, in the space of fifty feet, four thin bands of limestone, white and crystalline. These dip N. 65° E. $<$ 30° to 50°. These bands vary in thickness from four feet to six inches and appear to have eaten into the containing gneiss, as they penetrate the bedding and hold fragments of the surrounding rock. The dark gneiss is garnetiferous. The two middle calcareous bands coalesce, and at one point form a band fourteen feet thick. Below this point to the Point aux Dores, four other bands of limestone are seen, the associated gneiss being fine-grained and rusty. Some of this gneiss holds quite large masses of magnetite which is in fact a considerable ingredient in nearly all the gneisses in this area.

Mekinac River to Grandes Piles.

Below the Mekinac the river widens. The shore becomes sandy and the stream is bordered by terraces, the highest of which is about 150 feet, but the fine-grained reddish and gray gneiss continues in hill ranges down to the village of Grandes Piles.

At this place, on the east bank, the gneiss sometimes has a greenish tint from the presence of pyroxene, and contains veins of pegmatite and magnetite. The strike here is north and the dip east $<$ 30° to 50°.

Similar rocks continue down stream to Petites Piles. The strike changes to N. 30° E. but the dip is still east 20° to 30°. At the latter place there are two bands of limestone from six to thirty-six inches in thickness separated by a six-inch band of pyroxene. The calcareous bands are impure, holding dark mica and pyroxene with hornblende. Overlying these are about 200 feet of pyroxene-hornblende-gneiss with veins of pegmatite, which also hold masses of pyroxene, and these are followed by the ordinary gray gneiss of the district.

Pyroxene rocks.

Along this part of the river, for a distance of about one mile, the outcrops of limestone in thin bands are quite common. They are all associated with pyroxenic rock and are not continuous. The bands vary rapidly in thickness, and are sometimes entirely interrupted, re-appearing some feet further along the line of the strike. They frequently contain masses of the country rock, generally of pyroxene, and are more of the nature of segregations than of ordinary beds. In this way they more nearly resemble the masses of calcite which are found in the pyroxenes of the apatite district along the Ottawa, in which the crystals of mica and apatite occur. The colour of the limestone also resembles that found in the pyroxene mineral belt, varying from pink to white.

Limestone with pyroxene

Petites Piles to Shawenegan Falls.

From the Petites Piles to the Shawenegan Falls, the rocks are very similar in character to the gneisses already described. They are mostly grayish and reddish, and Mr. Low remarks that the gray gneiss generally contains, along with the mica, more or less black hornblende, while with the red there is a greenish variety, often decomposing into a mineral closely resembling chlorite. Garnets are a common constituent, and there is often much magnetite in small grains.

Shawenegan Falls.

The Shawenegan Falls have a descent of 160 feet. The rock here differs from that on the upper stretch of the river and is rather an augen-gneiss, showing distinct banding, mostly gray and moderately fine-grained. The felspar crystals are of good size and well drawn out. Reddish bands also occur and garnets are an accessory mineral. Some bands are highly hornblendic and have large disseminated crystals of that mineral. The strike at this place is N. 20° E., and the dip east. At the foot of the large basin below the falls the strike changes to N. E., and the dip to N. W. $< 60°$, and the same character of rock is thence maintained along the lower part of the river to the overlap of the Potsdam sandstone already referred to, nearly three miles below.

Contact with the Potsdam sandstone.

The upper bands of the gneiss underlying the Potsdam are uneven as if eroded before the deposition of that formation. The surface is

FOLDED BEDS OF GNEISS, BATISCAN RIVER, QUE.

A. P. Low, Photo., 1891.

FLAT-BEDDED GNEISS, BATISCAN RIVER, QUE.

decomposed to a depth of five feet and the rock here is of the schistose variety holding garnets.

THE AREA EAST OF THE ST. MAURICE.

Area east of the St. Maurice.

The area east of the St. Maurice was also traversed by Mr. Low in 1891, in continuation of his work on the north-east or "Quebec sheet." The northern portion is entirely unsettled, but is intersected by several streams, of which the principal is the Batiscan. Lakes, often of good size, are numerous, but the connecting portages are for the most part long and rough. The surface is hilly and thickly wooded and exploration is therefore rendered difficult.

Throughout all the area to the east of the St. Maurice there is a very great similarity in the character of the rocks where exposed, not only to those in the district itself, but to those already described for the country west of the St. Maurice, and they all apparently belong to the Grenville series of gneiss and limestone. The latter rock is rarely seen, but there are a few outcrops along the shores of several lakes west of the Batiscan River.

The Batiscan River.

This stream traverses the eastern portion of the map-sheet, entering it about ten miles west of the north-east angle and emptying into the St. Lawrence about eighteen miles east of the city of Three Rivers. It affords a good section from the crossing of the Lake St. John railway, diagonally across the strike of the rocks nearly to the village of Ste. Geneviève, where the country becomes low and the rocks are concealed by the great deposits of clay and sand that occupy the area to the north of the St. Lawrence.

Garnetiferous and gray gneiss.

On this river, from the crossing of the railway from Quebec to Lake St. John to the point where it meets the railway to St. Tite Junction, the prevailing rock is gneiss. This is usually the fine-grained banded mica and hornblende variety, and some of the layers are filled with garnets. The general strike is north and the dip is E. $<50°$. Near the railway bridge the rock is more massive for some distance, but the coarse- and fine-grained mica-garnet-gneiss again comes in and continues to the village of Nôtre Dame. At this place the railway leaves the river and continues more to the west while the stream turns to the south. Along the stream below this point, through the seigneuries of Grondines and Ste. Anne, the gray gneiss is associated with bands of quartzite and mica-schist.

The river from the Laurentides station on the Lake St. John line to Nôtre Dame, is generally rough and descends rapidly. There are but

Rough character of river.

few falls but a succession of heavy rapids. The valley is narrow and the hills rise on either side to elevations of 500 to 900 feet above the stream. Much gray and dark hornblende-gneiss occurs along this portion, with large blocks of the same. Some of the bands are almost entirely composed of black hornblende, but others contain felspar and mica, so that the gneiss as a whole has a well banded aspect. Approaching the railway bridge above Nôtre Dame, the rock becomes coarser and approaches a syenite in character, with associated areas of garnetiferous mica- and hornblende-schist. The more massive portions of this rock have been extensively used in constructing the piers of the railway bridge at this place and afford excellent material for building purposes.

Building stone

From the railway to the mouth of the Tawachiche River, the stream affords a fairly good section across the strike of the gneiss. In this distance the Batiscan is generally rough and broken by several falls. The rocks along this stretch are all similar in character, being for the most part a dark-gray schistose mica-gneiss, often containing hornblende bands and nearly always weathering rusty from the decomposition of iron-pyrites which is disseminated in small quantities throughout the strata. The strike is generally north-and-south with a dip to the east of twenty to forty-five degrees, but there are local flexings in which the strike sometimes changes to N. 50° E. The gneiss is frequently cut by pegmatite dykes, which often hold small crystals of light-coloured mica.

Gneiss of lower part of Batiscan River.

Through the seigneury of Montauban the elevation of the surrounding hills gradually decreases until they are rarely more than 400 feet above the stream. The land is cultivated for several miles below the railway bridge, and terraces continue down to the boundary of West Grondines, beyond which point they are concealed by forest growth

Terraces along stream.

Below the mouth of the Tawachiche River to the southern limit of the crystalline rocks, near the village of Ste. Geneviève, the river follows a nearly straight course and more closely conforms to the strike. At the mouth of the Pierre Paul River, the gray schistose gneiss often contains considerable beds of gray quartzite. The dip still continues to the east at angles of ten to forty degrees, and there are large and thick masses of pegmatite.

Below this, to Price's mill, while the rocks are of the same general character, there is also an admixture of garnetiferous-gneiss, and some of the mica bands are replaced by black hornblende, but these are comparatively few and thin. The gneiss is unusually quartzose and the schistose structure is common. This quartzose

Garnetiferous gneiss.

aspect of the gneiss is more marked as the eastern or southern margin of the area is reached. As the strike is very nearly along the course of the stream, no very great thickness of strata is exposed. The dip is nearly uniformly to the east, and the rocks very greatly resemble the bedded sediments of more recent formations, presenting much of the general aspect of bedded sediments in a highly metamorphic condition.

Bedded aspect of the gneiss.

Well-defined terraces are to be seen on both sides of this river for long distances. Three and sometimes four are common, the highest of which is at least 100 feet above the stream, while the others are at different elevations below that level.

Terraces.

The railway line from River Pierre Paul to St. Tite Junction affords a fairly good section for some miles west of the junction with the main line from Quebec to Lake St. John. Cuttings are frequent, but the rock outcrops are all very similar in character. They consist for the most part of gneiss, which is generally fine-grained and micaceous with occasional coarser bands.

Railway from River Pierre Paul to St. Tite Junction.

The gneiss is sometimes dark and hornblendic and masses of generally coarse pegmatite, which sometimes contain crystals of mica, are frequent. Very little quartzite was noted on this line of section. The strike varies from north to N.50° E. and the dip where recorded is generally to the east. Owing, however, to a lack of continuity in the outcrops there may be dips also to the west which are not apparent, as it is scarcely probable that the whole of the series, extending in section from east to west for nearly twenty-five miles, with great similarity in character throughout, is a uniformly descending one, since in that case the thickness of the upper gneiss series would be enormous.

Gneiss probably in folds.

Along the main line of railway to Lake St. John, which cuts across the north-west angle of the map-sheet, similar gneiss is exposed as far as the crossing of the Batiscan River. The cuttings are, for the most part, in a grayish-mica and sometimes hornblende-gneiss. Occasional bands of pinkish colour are also seen. The railway keeps nearly along the strike for the greater part of the distance and the dip here appears to be uniformly to the east.

Lake St. John Railway.

In the area to the north, between the Batiscan and the St. Maurice, several chains of lakes are found. Some of these lakes are of large size, and though the portages connecting them are somewhat difficult, canoe-routes exist between the two rivers and thus a fairly good opportunity is afforded to study the structure of the rocks throughout this district.

Among the principal lakes here that have been examined, are Island, Roberge and Masketsy, which are on the head of the Tawachiche River, Big Long and Mekinac lakes, which empty through the Mekinac River into the St. Maurice, some miles north of the Grandes Piles, and Lakes St. Michel, Trout, Sleigh, Castor and Batiscan, the two latter just beyond the limit of the map, which flow into Lake Mekinac. Of these, Big Long and Mekinac lakes are the largest, and they generally lie along the strike of the gneiss, which is a few degrees west of north.

Lakes between upper Batiscan and St. Maurice.

Big Long Lake.

On Big Long Lake the gneiss is usually a moderately fine-grained, banded gray and red variety, containing mica and hornblende. In places there are masses of reddish augen-gneiss, in which the augens are generally of pink felspar, and the rock also contains masses of this mineral. All these rocks are a good deal contorted and the various bands are often lenticular. Cliffs rise from the shores of the lakes to elevations of 400 to 500 feet above the surface. The recorded dip is generally N. 70° E. <10° to 50°.

The waters of Big Long Lake are yellowish in colour but very clear. On the east side the rocks rise almost perpendicularly from the water, while on the west the hills slope towards the shore in the direction of the dip. On Lake Mekinac the same succession of fine-grained red and gray well banded hornblendic and mica-gneisses are seen. Near the south end of the lake, cliffs similar to those of Big Long Lake appear, rising to a height of 400 feet, and about three miles from the lower end there is a sharp overturn in the gneiss, the dip changing from east to west and the angle increasing from 40 to 90 degrees. A short distance north of this, several thin bands of crystalline limestone occur, associated with green pyroxene. The width of the thickest limestone, which is pink in colour, is only eighteen inches. About midway on the east side of the lake near a small, deep bay, another sharp fold appears, with a band of limestone the exposed thicknss of which, in one place, is six feet. This band is white and holds small pieces of green pyroxene. Beyond this, northward, the rocks are much contorted, the dips changing rapidly, but the inclination soon becomes easterly, and this direction is maintained to the north end of the lake, with, however, a sharp anticline near the mouth of Brochet River, which enters the lake about two miles from the north end.

Lake Mekinac crystalline limestone.

Anticline.

Pyroxene rocks.

It is possible that the limestones here noted are portions of the pyroxene mass, rather than sedimentary beds in the gneiss, and that they are similar in character to those seen along the St. Maurice below Grandes Piles.

On the River Brochet, just mentioned, but few rock outcrops are seen. The stream flows through a low and swampy country to the forks with the Rivière à l'Eau Morte on which, at the falls, the same character of hornblende-mica gneiss appears with a south-east dip at an angle of forty-five degrees.

General character of the gneiss.

On the whole it may be said of the rocks on these lakes and of the area adjacent, that they consist almost entirely of reddish hornblende-mica-gneiss, generally moderately fine-grained and interbanded with dark- and light-gray gneiss which is more basic. Some of the bands are coarse, and garnets are sparingly disseminated through many of the bands.

Route between Lake Mekinac and the St. Maurice.

A portage of four miles leads across from a bay on the west side of Lake Mekinac to Trout Lake. Similar yellowish-weathering grayish hornblende gneiss appears about midway on the route with an east dip 10° to 40°, and the same rock, with some coarser red bands, in which garnets are common, is seen along the shores of Lake St. Michel. The rock in this direction is generally darker in shade and resembles that seen on the St. Maurice, containing iron and dark-green felspar. The country about Trout Lake is low and swampy, with rolling hills from fifty to a hundred feet above the surface of the lake, which has an elevation of about 300 feet above Lake Mekinac.

Returning to this lake, the west shore shows but few rock exposures as compared with the east side. Those seen are usually grayish and reddish mica-gneiss dipping E. $< 30^{\circ}$ to 60°. The descent to the St. Maurice by the river shows but few ledges, and those seen are of schistose hornblende and mica-gneiss, with occasional coarser bands. This river is a succession of small rapids, with a swift current as far as the mouth of the Rivière la Truite, and the banks generally are low and composed of stratified clay, overlain by coarse sand and gravel. Below the mouth of the branch from Trout Lake, to the junction with the St. Maurice, rock exposures are wanting.

Lake Masketsy.

Lake Masketsy is reached by a portage from the upper end of Big Long Lake. The rocks on this lake are very similar to those already described on Lake Mekinac, being mostly moderately fine-grained mica- and hornblende-gneiss, with dykes of coarse pegmatite. Some of the gray bands are rusty, but no limestone appears. A portage leads across from this lake to Lake Roberge, over a hill about 300 feet high, and the same kind of rocks are also there exposed, the dip being N. 70° E. $< 15^{\circ}$.

Lake Roberge and Island Lake.

From the north end of this lake, a portage-route, crossing several small lakes, extends to Island Lake, which is near the northern limit

of the map-sheet. On the first of these lakes the rock is a yellowish-weathering mica-gneiss, with a dip to the east of fifty degrees, and on the portage to the next small lake a white, highly felspathic gneiss occurs, composed mostly of orthoclase and quartz, with a little mica. Much of the country along this route is low and swampy, and for three miles before reaching Island Lake is without rock exposures. The gneiss on this lake is the usual hornblende-mica variety, but there are many intrusions of pegmatite and occasional bands of quartzite occur. The dips, where seen, are all to the east, at angles of thirty to fifty degrees. From the foot of this lake a creek flows into the north end of Lake Mekinac. The rocks along this route, which is very bad, are all of the same character as already described. In fact, there is a very great similarity in character in all the rocks throughout this area.

Sleigh Lake.

From the west side of Lake Mekinac a portage of three miles leads across to Sleigh Lake, on the way out to the St. Maurice. This portage passes over a ridge about 200 feet high, but falls again before reaching Sleigh Lake, which is about forty feet higher than Lake Mekinac. Exposures on this lake are few and consist of fine-grained reddish and yellowish gneiss with much quartz, and with grains of ilmenite. A portage one mile and a half in length, through swamps, leads thence to Castor Lake, where similar rocks are found, with pegmatite, and in places much contorted, and thence a half mile portage extends to Lake Batiscan, from which a creek flows into the St. Maurice. The rocks along this part of the section are all of the same general character.

Lake Batiscan

Gneiss of the eastern part of the area.

A traverse was also made from the line of the Lake St. John railway by the Black River in the eastern section of the map which included Lakes Montaubin and Long. In this section the only rocks seen were the usual varieties of light- and dark-gray mica-gneiss with occasional masses of pegmatite. The strike is uniformly north to north-east and the dip east $<20°$ to $50.°$

AREA SOUTH OF THE MATTAWIN.

Area south of the Mattawin.

This area has been very thoroughly traversed by Messrs. Ord, Adams and Giroux and in the eastern area, nearer the St. Maurice, by Mr. McConnell. Surveys of all the principal lakes and streams were made, mostly by micrometer, and most of the roads in the district have been also measured, so that the information in this area is quite complete, with the exception of certain practically inaccessible portions that are densely wooded and where rock exposures are concealed.

The principal rivers traversing this area are L'Assomption and the du Loup. These, in their upper part, are associated with extensive chains of lakes which are situated not far from the Mattawin, the height-of-land in this direction being only a few miles south of that stream. Traverses were also made of the smaller streams and lake connections between these waters and the Mattawin as well as of much of the flat country to the north of the St. Lawrence River. Principa rivers.

Of these the first line of exploration was along L'Assomption River from the town of Joliette north to the junction of Black River, which is one of the principal tributaries from the north-east. Then along this stream and its lakes to Lake Maskinongé which was reached by the Mattambine River. This lake is near the village of St. Gabriel de Brandon, and from this, north, a traverse was made by way of the Mastigouche and connecting lakes to the Rivière du Loup which was followed down to its junction with the St. Lawrence. L'Assomption River.

The lower portion of L'Assomption River, or that part between the town of Joliette and the first outcrops of the crystalline rocks, is very crooked. The stream winds between banks of clay, sand and gravel, with occasional outcrops of the Palæozoic formations which have already been referred to in previous pages. The first appearance of the gneiss is at a point known as Nadeaus Rapids, about twenty miles from Joliette by the stream. At the foot of this rapid are ledges of gray hornblende-gneiss, associated with layers which are highly quartzose and having a dip of S. 40° E. $<14°$. Thence up stream, to the mouth of Black River, rock exposures are numerous, though for considerable stretches along the river the banks are composed of sand, clay and gravel. Rocks along L'Assomption River.

The prevailing rock of the district is a gneiss. This varies from a grayish quartzose, sometimes rusty, rock to a dark hornblendic variety, and in the upper half of the distance the bands are frequently highly garnetiferous. While the banding is generally well defined, there are, along certain portions of this distance, outcrops which are granitic in character and where only an indistinct foliation can be perceived. Rapids and falls caused by harder masses are frequent. In places the gneiss, which has a regular dip for the greater part of the course, is broken through by masses of pegmatite and sometimes of diorite, and the rock in these cases is usually much shattered and disturbed. Black River was followed upward through Black Lake to near the post between lots 20 and 21, range XI and XII, Brandon, whence a portage was made to Lake Mattambine, which discharges by the Mattambine River into Lake Maskinongé. Garnetiferous gneiss.

Black River.

The rocks along Black River are all gneissic. They are often highly quartzose with hornblende and mica and have interstratified bands of reddish-gray colour. In places the rock is highly micaceous and sometimes very rusty, resembling the bands in association with the Grenville series, though no calcareous bands were observed along the stream. The strike changes to N. 20° W., and the dip is to the east at a low angle. Near Black Lake the gneiss is a gray-weathering brownish-gray rock with quartz layers. The banding is well defined and the crumpling in some parts is very marked though the dip continues to the north-east. The upper portion of this stream flows through a low and swampy area, and rock exposures are rarely seen. The only rocks exposed around Lake Mattambine are quartzites and grayish, sometimes rusty gneiss. Along the Mattambine River to Lake Maskinongé the only exposure is a dark hornblende-gneiss, about midway, but the bed of the stream is almost choked in places by boulders of grayish gneiss and anorthosite.

Lake Mattambine and river.

Lake. Maskinongé

Lake Maskinongé receives the waters of the Mastigouche River and the chain of lakes at its head. The stream enters the north end of the lake, while the discharge is by the Maskinongé River, which flows into the St. Lawrence near the upper end of Lake St. Peter.

The shores of this lake are for the most part formed of sand and boulders. Ledges are seen on the west and south between the mouth of the Mattambine and the village of St. Gabriel de Brandon, where bedded brownish-gray and gray quartzose mica-gneiss dips N. E. $<5°$. About one mile north of the village a hill of reddish-gray and gray imperfectly foliated granite-gneiss, with masses of hornblende-gneiss inclosed, rises from the water to a height of about 150 feet.

Granite near St. Gabriel de Brandon.

On the shore east of St. Gabriel, a reddish-gray granite appears being the western edge of a great mass of this rock, which has a large development in the county of Maskinongé, between St. Gabriel and Hunterstown. In places this rock is coarse and granitic, without trace of bedding or foliation; but along the margin of the outcrop, at a number of places, a well-defined foliation is visible and garnets are disseminated. Magnetite in small quantities is present and patches of bluish-white quartz occur in the granite mass. This granite will be referred to on a subsequent page.

Mastigouche River.

From the upper end of Lake Maskinongé, the Mastigouche was surveyed for fourteen miles to the portage to Chute Lake. On this part of the stream the ledges are few and are all of greenish-gray gneiss with reddish bands, the dip where observed being E. $<20°$. The river is

obstructed by heavy falls and rapids so that the traverse is difficult for several miles below the lake.

The only rocks around Chute Lake are the usual brownish-gray and gray gneiss, in places filled with garnets and with the usual east dip at a low angle. From this lake the Mastigouche was ascended for a further distance of twenty miles north, when a portage was made to Lac Sans Bout on the Rivière du Loup. A route from this lake leads to the Mattawin and reaches that stream a few miles north of the village of St. Michel, by way of Lakes Ignace and Barré. On this route several other lakes are traversed, and on the whole distance from Lac Sans Bout to the Mattawin, eighteen lakes and seventeen portages were surveyed. The principal of these are Lakes Clear, Lézards, Etroit, Bottle, Ignace and Barré, the latter discharging into the Mattawin.

Routes from Lac Sans Bout to the Mattawin.

On all these lakes the rocks differ very little in character. They consist of the same reddish, brownish and gray gneiss, in places holding quartz and garnets like the rocks described in the area to the north of the Mattawin. The dips for the most of the distance are to the south-west and the angles are low. In places the gneiss is much disturbed, probably through the action of granite masses. The only calcareous rock seen along this route was on a small lake a short distance to the north of Lac Sans Bout, where there is a conglomeratic appearance in certain bands of quartzose rocks, in which the paste is calcareous with lumps of dark and gray gneiss, but no well-defined limestone bands were seen.

Garnetiferous gneiss.

On the south side of Bottle Lake, near the inlet, a cliff of gneiss rises to a height of 300 feet above the water. The rock is a gray colour with the banding well-defined, often quartzose and sometimes hornblendic. The quartzose bands are filled with garnets and some of the bands contain felspar, quartz and pink calcite, the latter holding much iron in small grains. Small grains of iron-pyrites occur, and the face of the cliff is stained in places with iron rust resulting from the decomposition of this mineral. On Lac aux Lézards a well-defined anticline is seen in the gneiss. The angle of dip is low, rarely exceeding twenty degrees. From Lac Ecartant to Lac Sans Bout the dip is for the most part to the south-west, showing the presence of the same structure along this part of the route. The same series of dips is seen along Lac Sans Bout, though the ledges along the river are few, as the banks of the stream are generally low.

Bottle Lake.

Anticline.

From Lac Sans Bout a chain of smaller lakes including Lakes Violon, Bleu, and Ecorces, Culbute and Welly, leads to Lac Sac-à-

Lac Sans Bout to Lac Sac-à-Commis.

Commis, which is one of the largest in the area. The rocks along this route are reddish and brown gneiss, often garnetiferous, with occasional small masses of syenite near the last-named lake. The dips are generally to the south-east at angles of twenty-five degrees.

Lac Sac-à-Commis.

On Lac Sac-à-Commis, near the north end, the syenites again appear, but the ledges along the shores are generally of reddish and gray gneiss of the usual type. At the south-west end of this lake large exposures of reddish granite-gneiss are seen, and at the end of the long point running into the lake from the north end, dark-gray and rusty gneiss is interstratified with the red, and dips east at a low angle. Similar gneiss occurs on the large island near the middle of the lake. On the east side of the lake the gneiss is schistose and well-foliated.

Rivière du Loup.

From the east side of Lac Sans Bout a branch of the Rivière du Loup flows northward to Lac au Sorcier and thence to the main branch of that stream, and a second route in which, however, the portages are long, extends across from the north end of Lac Sac-à-Commis by way of Lake Carufel, which reaches the same branch of the Rivière du Loup about ten miles farther south. On both these routes, which cross the strike of the gneiss diagonally, the only exposures are of the reddish-gray and gray garnetiferous gneiss. The dips are all to the south-east at an inclination of twenty to thirty-five degrees. The gneiss along the Lake Carufel portage is very quartzose with a small quantity of disseminated graphite. The garnets are very abundant in certain bands everywhere along this route.

Portage-route from Mattawin to Rivière du Loup.

From the point where the portage-route from Lac Sans Bout reaches the Rivière du Loup, a route extends across to the Mattawin by way of the upper du Loup and the Michelin Brook. On this route are a number of lakes, the principal being Lafond, de la Ferme, Sand, Bay and Long Lakes. The Michelin Brook is about four miles long and has a lake at its source. On all these lakes the reddish-gray and gray gneisses are the prevailing rock. In places these are garnetiferous, and on the southern half of this part of the section the dips are to the east or south-east, but on the northern portion the dip changes to N. 25° E. and N. 25° W. The angles of dip are low rarely more than ten to fifteen degrees.

Rivière du Loup to Hunterstown.

Along the lower part of the Rivière du Loup section, for some miles, from the end of the creek flowing from Lac au Sorcier there is very little difference in the aspect of the gneiss, wherever it is seen, to within six miles of the village of St. Alexis. Along this lower portion of the river the rocks are more granitic, but with these also there are certain areas which show well-defined foliation and in places banding. From

the village of St. Alexis down to the big bend where the river turns east in the direction of Hunterstown, the rock is distinctly granitic in character, forming the eastern limit of the large red granite and syenite mass which appears to the east of the village of St. Gabriel de Brandon. On the north-east stretch of five miles to Hunterstown, the rocks again are grayish often quartzose gneiss, with rusty bands in the vicinity of that village, and here the gneiss is associated with several thin bands of crystalline limestone. Below Hunterstown the rocks are generally grayish garnetiferous gneisses of the usual type, and at about four miles south of that place these are covered over by the sands and gravels of the St. Lawrence valley.

The geological features of a large portion of the counties of Berthier, Joliette and Montcalm, included in the south-west part of this map-sheet have already appeared on the map accompanying the report by Dr. Adams, previously referred to. This area is fairly well opened up by roads, so that the study of the geology is much less difficult than that of the great wilderness country to the north and east which has just been described. In addition to the large areas of grayish gneiss which represent the Grenville series in this district, there are also masses of anorthosite and granite, which, from their relations to the gneiss and limestones, are clearly intrusive in and newer than these. The outlines of some of these masses have already been given in the map referred to. The strikes of the gneiss are generally to the north or north-west, and the angles of inclination are low. The banded gneisses are thrown into a series of low undulations, and there are several narrow bands of crystalline limestone. These, however, cannot be traced continuously to any great distance on their strike, but disconnected outcrops appear at intervals which may represent portions of bands that may at one time have been continuous, but which through denudation or from other causes, have disappeared over long distances. Throughout this area, there is a marked similarity in the characters of the gneiss, to what is observed in the gneiss and limestone areas of the Grenville district, north of the Ottawa. The descriptions of the various rocks found in this district are so fully given in the report by Dr. Adams, * that further reference is unnecessary here.

Gneiss of the Grenville series.

Crystalline limestone.

A reference has also been made by Dr. Adams in the report just alluded to, to the area of granite that occurs near the centre of the sheet and to the north-west of Lake St. Peter. This area was outlined first by Mr. R. G. McConnell in 1880, and its boundaries were subse-

The great granite area.

* Annual Report, Geol. Surv. Can., vol. VIII, (N.S.), 1895, pp. 11 to 30 J.

quently revised in part by Mr. Giroux in 1891 and 1893. While other areas of similar rock are recognized at different points in the area under consideration, this is by far the most important as yet seen. It is somewhat irregular in outline, and has a length of about twenty-eight miles from the south-west angle in Berthier to its north-east end in the township of Belleau in the county of St. Maurice, and with a maximum breadth of about fourteen miles in the townships of Hunterstown and Decalonnes.

Character of the granite.

The granite varies in character at different points. Sometimes it is coarsely crystalline and massive, with but small traces of foliation, while at other points it is fine-grained and a well-marked foliation is observable. It occupies a large part of the townships of Berthier, Decalonnes and Hunterstown, as also of the Fief Hope which is a portion of the township of Lanaudière. Its south-west extremity is in the shape of a long narrow tongue, the width of which must be somewhat conjectural, since it is largely concealed by the drift of the St. Lawrence basin.

Granite and anorthosite.

In the vicinity of this granite mass are other smaller intrusions of anorthosite and granite in the counties of St. Maurice and Maskinongé. In their relations to the surrounding rocks of this area, these granites and anorthosites are also of more recent date, since at a number of places they are noticed as cutting off the gneiss across the strike, while on either side of the main mass to the south of St. Gabriel de Brandon, the presence of the granite has changed the strike of the surrounding gneiss, so that the latter now follows the general outline of the granite mass. The petrographical features of these rocks have been fully discussed by Dr. Adams in his report, previously referred to, p. 31 J.

Rocks of the Grenville series.

Generally speaking, therefore, the rocks of the greater portion of the map-sheet, excepting the Palæozoic formations, may be regarded as representing the portion of the Grenville series beneath the crystalline limestones, which are but sparingly represented. In the Grenville district the calcareous members are found to occupy largely the synclines in the underlying gray quartzose gneiss. While a similar structure as regards the presence of anticlines and synclines is found in this area, there is this difference, that in the St. Maurice portion the gneiss layers and undulations are in a much more nearly horizontal position than in the Grenville area where the strata are generally highly inclined. The calcareous members, therefore, if they ever were deposit ed in the former area as seems probable from the scattered remnants of that portion of the series now found, have probably to a large extent been removed by denudation. The gneisses seen are, for the most

part, of the altered sedimentary series, rather than pertaining to the lower or what has been styled the Fundamental Gneiss of the Laurentian.

SURFACE GEOLOGY.

Allusions have already been made in the preceding pages to certain surface deposits of sand and clay found throughout the area comprised in the accompanying map-sheet. Near the St. Lawrence River the broad and nearly level plain which extends for some miles, both to the north and south of that river, is occupied almost entirely by these deposits. In these, marine shells are rarely seen, but sometimes occur in the overlying sandy beds. In this respect these deposits very closely resemble those found along the lower Ottawa and between that river and the St. Lawrence above Montreal, where the occurrence of marine shells in the gravels overlying the clays is a very common feature, while the clays themselves are for the most part without visible organic remains. Marine shells in sand above the clay.

The clay deposits in the St. Maurice district underlie the sands along the river courses for many miles north, and in some places to the height-of-land. The overlying sands are seen in the flat country near the St. Lawrence as well as in the more elevated areas to the north. Nearing the height of-land, the surface of the country becomes much more level and is largely covered with sand and gravel over which boulders of gneiss and granite, often of large size, are sometimes strewn. In none of these northern deposits have we yet been able to find marine shells. Along the large streams well-defined terraces are common. Of these there are generally four, the upper of which has an elevation of about 150 feet above the adjacent stream, and these can sometimes be traced for miles. Along the shores of many of the inland lakes the deposits of sand and water-worn stones sometimes form banks up to fifty feet or more in height. Absence of marine shells in upper St. Maurice terraces.

Glacial striæ are not numerous. In the gneiss area the rock does not readily retain these, though grooves are sometimes seen, while the Palæozoic formations are for the most part so covered by drift that rock outcrops are rarely met with. The general direction of those noted is from north to south or toward the St. Lawrence from the height-of-land. The course of the ice, judging from the striæ, has been to some extent influenced by the topographical features of the country. Thus on the Batiscan River, Mr. A. P. Low records several between the crossing of the Lake St. John railway and the village of Ste. Geneviève where the rocks become concealed by drift, which range Glacial striæ

from S. 10° to 20° E. Along the line of railway to St. Tite junction the same apparent course is maintained. At Grandes Piles on the St. Maurice River, the course of the striæ is about south, and below that place towards the city of Three Rivers it varies from S. 15° to S. 40° E.

On Big Long Lake it is S. 40° E., on Lake Mekinac S. 20° E. and on Lake Roberge S. 10° W., while at the mouth of the Rat River, on the St. Maurice, which is just above the limit of the map-sheet, the recorded course is S. 30° W.

Glacial grooves.

West of the St. Maurice, there are few recorded markings. On the upper Mattawin grooves were noted at two places, the course of which was very nearly north-and-south. Near Ste. Ursule, Mr. Giroux records two exposures showing north-to-south striæ, and a little to the south of St. Gabriel de Brandon village, an exposure shows striæ with a course S. 35° E. Near the village of Ste. Emilie striæ are recorded as S. 15° W.

Shore-lines.

Shore-lines were noted by Mr. R. Chalmers at a number of points in this area. Of these the highest recorded by him was at Lake Maskinongé with an elevation of 865 feet and on the St. Maurice at 670 feet, above sea-level. Other shore-lines doubtless exist but are difficult to trace owing to the dense forest growth of this upper country.

A supplementary chapter on the clay-deposits of the St. Lawrence area, with special reference to the remarkable landslides near the Rivière Ste. Anne de la Perade, by Mr. Chalmers., is appended

ECONOMIC MINERALS.

Full notes are given of the economic minerals found in the area west of the St. Maurice, in Dr. Adams's report previously referred to pp. 140-154 J.

Iron-ores.

The most important mineral deposits yet found in the St. Maurice district are those of bog-iron ore, which have been worked almost continually for a century and a half. The history of these workings has been given at considerable length in the writer's report on the Mineral Resources of Quebec,* and need not here be repeated. The mode of working the deposits has been entirely remodeled within the last ten years, by the erection of a new and modern smelting plant, including blast-furnace, coke-ovens and other appliances for obtaining and smelting the ore which is disseminated over a very large extent of

* Annual Report, Geol. Surv. Can., vol. IV, (N S.) 1888-1889, part K.

country both to the north and south of the St. Lawrence. Reference is made in the Summary Reports of Messrs. Low and Giroux for 1891-92 to some of the principal sources of supply of the ore. Of these one of the most important is at Lake Tortue, where the material is largely obtained by dredging from the lake bottom by machinery specially constructed for that purpose. The waters of this lake have also been lowered about four feet so that a large amount of the ore can be obtained by digging. In this connection we may quote from the statement of the Radnor Iron Co. in the Canadian Mining Manual, 1898. The Radnor Iron Co.

'The company at present owns an area of 100,000 acres of bog-ore rights in the districts of Champlain, St. Maurice, Three Rivers, Vaudreuil, Joliette, St. Ambrose de Kildare, Pointe du Lac, Gentilly and Bécancour, including the important deposits (supposed to be the largest of like nature in the world) of lake ore in Lake Tortue and Lac au Sables.

' Lake ore is raised principally at Lake Tortue, where a steam dredge of a capacity of fifty tons a day is employed. The deposits vary somewhat in analysis ; some of the bog- ores used by the company being as low as ·080 sulphur and ·042 phosphorus. Lake Tortue.

'The lake iron ore is found scattered over the bottom of the lake in an unctuous light-coloured mud made up of decayed vegetable matter. The ore does not appear to be found deeper than twelve or fifteen inches below the surface of the bottom and is most plentiful in the upper parts of the mud. It occurs in the form of porous, flat, rounded concretions, very irregular in colour. The concretions vary from a fourth to twelve inches in diameter and from a fourth to two inches in thickness, and closely resemble the dried excrement of cattle. The country surrounding Lake Tortue is almost flat, being a great swampy plain underlain by stratified clays, and covered in many places by extensive swamps. The underlying sands are highly impregnated with oxide of iron, derived from the decomposition of the rocks in the neighbourhood, which are highly charged with titaniferous iron ore. The iron in these sands is leached out by the action of acids, and fresh ore is being constantly formed, so much so that paying quantities of ore have been obtained from parts of the lake bottom which had been worked over thoroughly only a few years previously. As the lake is quite shallow and the depth increases slowly from the shore, the whole bottom can be worked over by the dredge belonging to the company. The dredge is of the endless chain pattern, with four rows of buckets. The buckets bring up the ore mixed with large

Ore of Lake Tortue.

Method of collecting.

quantities of mud, which they empty into a long cylindrical sieve, having rows of water jets inside. The sieve is slowly rotated and the ore tumbling through is washed clean and discharged on scows moored alongside, and then towed to the railway at the west end of the lake, The company has lowered the level of the water several feet, exposing a wide margin of the deposit, which is worked by hand. This is shovelled into round iron sieves and the ore washed out and made into heaps along the shore.'

Forges at Fermont.

The company's forges and plant, with the exception of the coke ovens at Grandes Piles and Lac au Sables, are situated at Fermont on the Rivière au Lard. The furnace has a capacity of forty tons a day of high-class charcoal iron which is specially suited to the manufacture of car-wheels. The furnace stack has a height of forty feet, bosh eight feet in diameter, crucible five feet in diameter, height of bosh line from hearth, eleven feet, with four tuyeres of three and a half inches diameter, the crucible and bosh being protected by a water-jacket. The furnace top is provided with a bell and hopper, having a capacity of twenty-five bushels.

This plant is fitted with the most modern appliances in the matter of hot-blast stoves, blowing engines, &c. The output of charcoal iron for 1897 was 8,512 tons, for which 836,000 bushels of charcoal were made.

Other ore-deposits.

The Radnor Company, in addition to the ore-deposits west of the St. Maurice, obtains a certain amount of bog-ore from the vicinity of Joliette, on ranges III. and IV. of that township, in the parish of St. Ambrose, where a somewhat extensive deposit of this ore is found. A small deposit of magnetic ore has also been worked on the concession St. Charles, in the Parish of Ste. Ursule. Other deposits of bog-ore were noted by Mr. Giroux at various places in the area west of the St. Maurice, but the extent of all these appeared to be small.

Mica deposits of the Mattawin district.

The deposits of mica on the upper part of the Mattawin have already been noted by Mr. Giroux.* They have also been referred to on a previous page. No work has been done in this direction for a number of years, and they do not appear to possess much value at the present time. At other places in this northern area, crystals of mica were seen in connection with some of the pegmatite veins, but no attempt has ever been made to determine their economic value and their present inaccessibility is against their development.

* Summary Report, Geol. Surv. Can., 1892, p. 43.

The iron ochre on the Milieu River is situated about three miles and a half north of Pine Lake, which is on the upper part of the Mattawin River. The material is of two colours, a vandyke brown and an indian red. Several tons were shipped some years ago to Montreal by the owner of the property, Mr. Gaucher, but the distance to railway, about sixty miles by the Brassard road, is against its profitable development.

Iron ochre of the Milieu River.

The ochre deposits near Three Rivers, which have been worked at intervals for forty years, are still worked by the Canada Paint Company and the Champlain Oxide Company. The output is variable apparently from 1,000 to 1,500 tons of ochre per year.

Ochre near Three Rivers

Infusorial earth is found at two places in the area west of the St. Maurice. One of these is in the concession Trompe Souris, of the Parish of St. Justin, where it occurs in small quantity at a few feet below the surface in a sand-bank, sixty to seventy feet high, and near a small ravine. The other deposit is on lot 15, R. V., Chertsey, at the bottom of a marshy bay on Lac Michel, and has an area of three to four acres, with a thickness of eighteen inches.

Infusorial earth.

Quarries of excellent limestone for building purposes are found at several places in the Palæozoic formations. They are located for the most part in the Trenton formation. Of these the principal are near the town of Joliette, which is just south of the limit of the map-sheet. The others are Barrette's quarry, near St. Barthélémi, Berthier county, Gagnon's quarry, near the village of St. Justin, Maskinongé county, Fafard's, Defond's and McGee's quarries, near St. Cuthbert, and Robillard's quarry, about four miles north-east of Joliette. Along the Chaloupe River also there are large exposures of lower Trenton limestone, which should furnish good material for building and lime-burning.

Limestone quarries.

At the Radnor forges, Fermont, there is a good outcrop of apparently Trenton limestone, which has been quarried for local use, and should afford a good quarry site. From none of these localities were any details as to output obtained, and all are worked apparently for local consumption only.

Borings for natural gas were made some years ago near the villages of St. Justin and St. Barthélémi, north of the St. Lawrence. Gas was found in small quantity at a depth varying from sixty to eighty feet from the surface, but the borings were apparently not carried to a depth sufficient to establish any conclusions as to the actual value of the area as a producer of this material. These borings probably started in the Trenton limestone.

Natural gas.

The borings on the south side of the St. Lawrence have already been incidentally referred to. They have been described by Mgr. Laflamme in a paper to the Transactions of the Royal Society of Canada in 1887, Vol. VI., and have also been discussed by Mr. Obalski, in a report of this area in 1885. The results of the work done in this district are given in the report by Dr. Selwyn in vol. III. 1887–88, pp. 33-34A. In the deepest hole which was put down in the vicinity of St. Grégoire, Nicolet county, the boring started in the red shales of the Medina formation, which were found to have a thickness of 655 feet at this point, and were continued downward in the underlying Lorraine shales and thin limestones to a further distance of 540 feet. It would appear that the Utica shales were not penetrated nor was the underlying Trenton reached, which was supposed to be the true source of the gas. Gas was, however, struck at a depth of 68 feet from the surface and an abundant flow at a depth of 640 feet, the latter sufficient to hurl mud and stones to a height of sixty feet into the air. When the hole was abandoned at a depth of 1115 feet, the gas continued to flow with such force that the orifice was not closed and at the last accounts the bore-hole was still discharging gas. It is to be regretted that this boring was not carried down to the top of the Trenton formation, so that some definite information as to the thickness of the formations in this area might have been obtained and important facts as to the probabilities of gas in this part of the St. Lawrence valley secured.

Boring near St. Grégoire.

Note.—In a recent report by Mr. Obalski, Inspector of Mines for Quebec, upon a boring made in 1899, near St. Grégoire, very salt water is stated to have been found at a depth of 605 feet, but no gas in economic quantity was struck.

APPENDIX I.

NOTES ON THE PLEISTOCENE MARINE SHORE-LINES AND LANDSLIPS OF THE NORTH SIDE OF THE ST. LAWRENCE VALLEY.

BY ROBT. CHALMERS.

The marine plain or bottom land of the St. Lawrence valley on the north side of the river between Quebec and Montreal, is of irregular extent, in some places being only eight or ten miles wide, in others twenty or thirty. The height of the plain seldom exceeds fifteen or twenty feet along the river bank, but it increases to 400 or 500 feet at the northern limits which usually rest on the base of the Laurentide hills. The junction of the plain with these hills forms a very irregular line often running up the river valleys in loops for considerable distances. Generally speaking, this line can be traced approximately on a good map from the absence of lakes on the marine area, whereas on the Laurentian area lakes are quite numerous. Occasionally the surface of the plain is seen to ascend by steps proceeding from the St. Lawrence River to the base of the hills, each of these steps having apparently been a shore-line for some length of time at a certain stage of the emergence of the valley from beneath the sea.

Extent and elevation of the marine plain on the north side of the St. Lawrence River.

Skirting the inner border of the plain along the hill slopes, terraces and ancient beaches occur which were evidently sea margins, or shore-lines, during the Pleistocene subsidence of the region. The altitudes of these have been measured in a number of places.

Terraces and shore-lines.

The Saxicava sands and deposits which constitute these uppermost shore-lines or beaches, merge almost imperceptibly into the sands and gravels of the higher levels, often quite thick, which occupy the valleys among the Laurentide hills.

The elevations of the shore-lines observed within the area of the Three Rivers map-sheet of the 'Eastern Townships series' are here given. They are based on the profile heights of the Canadian Pacific railway, and referred to mean sea-level. The only instruments used were aneroids, and the results must, therefore, be regarded as mere approximations, more especially as a number of the points levelled are situated at considerable distances from the railway. To correlate the shore-lines in the particular district in question with those of which

Height of shore-lines; how measured

the heights have been measured to the east and to the west, we shall commence at Quebec city and follow them westward to Lachute on the north side of the Ottawa River.

Shore-lines at Quebec.

1. North of Quebec, on the Charlesbourg road, two shore-lines were observed. The first and lowest occurs at Charlesbourg village, at a height of about 450 feet. The higher one was found about six miles from Quebec at 560 feet. Both are well-defined.

At St. Ambrose.

2. Near St. Ambrose, on the old Quebec and Lake St. John railway, Mr. A. P. Low, of this survey, discovered Pleistocene marine shells in Saxicava sand at an elevation of 515 feet above the level of the sea. * In the vicinity terraces of this sand were observed at a height of about 600 feet.

North of Portneuf.

3. North of Portneuf station, Canadian Pacific railway, on the road to St. Eustache, well marked shore-lines were found at 350 to 360 feet, and at St. Raymond at about 475 feet. To the north of this village they were noted at a height of 600 feet or more.

At St. Tite.

4. At St. Tite village sand and gravel terraces occur at about 670 feet. These are continuous with and apparently form part of the St. Maurice sands, so extensively developed in the valley of St. Maurice River, and well known as a marine deposit. †

Ste. Flore.

5. At Ste. Flore, on the west side of the St. Maurice River, a shore-line was found at 565 feet, and a higher one seen on the flanks of the hills to the north, which, however, could not be reached at the time of my visit.

Near Lake Maskinongé.

6. South of Lake Maskinongé, in the vicinity of St. Gabriel de Brandon, terraces and benches were observed at the following points:—

Near St. Gabriel station, Canadian Pacific railway, a well-defined terrace at 675 feet.

To the south-west of the last, another terrace or bench at 725 feet.

Further to the south-west a third was noted, which at two or three places was found to be 825 feet high; while still further up the slope a fourth occurs at 865 feet, but imperfectly defined and not continuous for any distance.

The Laurentide hills here rise to altitudes of 1000 feet or more, and the terraces flank them, facing the marine plain of the St. Lawrence valley.

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*Annual Report, Geol. Surv. Can. vol. V., (N.S.) 1890-91, p. 55 L.

†Geology of Canada, 1863, page 887.

VIEW OF LAND-SLIDE IN RIVIÈRE BLANCHE VALLEY AND OF NARROW OPENING THROUGH WHICH IT ISSUED.

7. On Mount Royal, Montreal, Pleistocene marine fossils have been found, as is well known, up to a height of 560 feet, and 'Dr. F. D. Adams and Baron De Geer observed a distinct beach at about 615 to 625 feet.'* At Mount Royal.

8. On the road leading from St. Jérôme to Ste. Camille good shore-lines were seen at the following elevations :— Ste. Camille.

(1) A well-defined terrace at............ 700 to 725 feet.
(2) A second at .... 760 to 765 "
(3) A third and the highest seen here, distinct in places, but not continuous, at 895 feet.

9. To the north of Lachute a terrace occurs at 745 feet, which may represent a shore-line. East of Dunany, on the road to Shrewsbury, however, great gravel mounds and terraces were observed at 845 feet; while to the north of this and about ten or eleven miles from Lachute station, Canadian Pacific railway, an extensive, horizontal sand and gravel terrace, composed of water-worn materials occurs. Several kettles, holding small lakes, such as are seen in the Saxicava sands of Three Rivers in the St. Maurice valley, were observed in this terrace, and in some places kame-like ridges occupy its surface. Height 975 feet. North of Lachute.

No barrier exists between these terraces and the open St. Lawrence valley.

From the foregoing facts it will be seen that the shore-lines increase in height from east to west, the average gradient of the highest between the city of Quebec and Lachute being about two feet per mile. They have not been traced continuously, however, even within the limited distance included in the Three Rivers map-sheet, as the hill slopes were in many places found to be covered by forest at the time of my examination. The maximum upheaval is, nevertheless, believed to be shown by the highest of the shore-lines given in the above record of observations, and its differential character may be considered as established. Average gradient of shore-lines.

Landslips.

A remarkable landslip happened in the Rivière Blanche valley, Portneuf county, in the province of Quebec, on the 7th of May, 1898. This landslip destroyed a large portion of three farms with the buildings thereon, and the quantity of material which was discharged into the river valley was so great as to fill it to a depth of twenty-five feet or more for a distance of nearly two miles. The people living on the Rivière Blanche landslip.

*The Ice Age in Canada, p. 63. By Sir J. Wm. Dawson.

farms which were damaged had to flee for their lives, all escaping but a little girl who was buried in the débris. This catastrophe occurring so soon after the one which took place at St. Albans, on the Rivière Ste. Anne de la Pérade, directed attention to these peculiar phenomena, and some investigation as to their character and causes seemed to be necessary. Accordingly, Dr. Dawson, Director of this Survey, having first made an examination of the Rivière Blanche landslip instructed the writer to proceed to St. Thuribe and further investigate this and the landslip at St. Albans and report thereon. Mr. J. Keele accompanied me and carried out the work of measuring the area of the former and photographing its principal features.

Three landslips of considerable magnitude have been known to occur in this part of the St. Lawrence valley within the past sixty years, and evidences of others, of which there is no account, were observed.

Maskinongé landslip.

The first of those referred to, took place on the bank of Maskinongé River, about nine miles to the south of the granite hills, on the 4th of April, 1840, and was examined and described by Sir W. E. Logan*. The area affected was about 84 acres and the chasm is described as oblong in shape, with the narrow funnel-like end towards the river. The total length was about 1,300 yards, while the breadth varied, the widest part equalling 600 yards. When examined by Sir W. E. Logan, the bottom of the widest part of the pit was found to be thirty feet below the level of the surrounding country. The material transported into the valley of the Maskinongé River filled it to a depth of 75 feet for a mile and a half. The cause of this landslip, Logan believed to be pressure on an inclined plane, assisted by water although no subjacent rock-surface was seen.

St. Albans landslip.

The St. Albans landslip occurred on the 27th of April, 1894, on the west bank of the Ste. Anne de la Pérade, about four miles above the village of St. Albans or seven miles distant from the Rivière Blanche landslip. Here the deposits (Leda clay and Saxicava sand) slid down bodily into the valley of the river for the space of three miles and a half. The landslip seems to have been in three parts, the first movement being at the northern end, where it was about ten feet deep. This was followed, after some hours, by another which took place immediately to the south of the last; and finally a third descended, just below the second, leaving a pit, 175 feet deep. The average depth of the whole chasm was not less than 100 feet below the general surface of the ground, and its width about a mile. The mass of material

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* Proc. Geol. Soc. of London, vol. III, 1838-42, pp. 767-769.

thrown into the valley of the Ste. Anne permanently changed the course of the river.

Published descriptions.

This landslip has been described by Mgr. Laflamme of Laval University, Quebec,* and by Messrs. Archibald and Mackenzie of the Chief Engineer's Office, Intercolonial railway, Moncton, N.B.†

The Rivière Blanche landslip was closely similar to that of Maskinongé River, described by Logan. As stated above, it took place on the east bank of the Blanche, a tributary of Ste. Anne de la Pérade, at St. Thuribe, about three miles north of St. Casimir village. The banks of the latter river are low and the country flat, forming part of the St. Lawrence plain, as far up as St. Thuribe, where the valley is crossed by a boulder-clay ridge. The superficial formations consist of Saxicava sand and Leda clay and boulder-clay. In the pit where the landslip occurred the Leda clay is prolific in marine shells, chiefly *Leda arctica* and *Macoma Grœnlandica.*

The chasm remaining from this landslip is also irregularly oblong in shape, like that of the Maskinongé valley described by Logan, with a narrow opening at the end towards the Rivière Blanche. At this point the breaking down of the beds began, and through this opening the whole of the flowing material of the landslip was discharged. The length of the pit, east and west, is about 1,050 yards, extreme width, 600 yards, maximum depth, about 28 feet; total area, 86 acres. The descent of the bottom throughout its whole length is approximately 27 feet, or about ten inches to the hundred feet, and the gradient is comparatively uniform from the eastern end to the present bottom of the river.

Description of Rivière Blanche landslip.

The movement of clay and sand on such a low gradient, it is obvious, could only have taken place when these materials were in a semi-liquid condition, and from all accounts the landslip resembled the bursting of a reservoir of water. Those who witnessed it, however, informed me that very little water was seen, the flowing mass consisting of a very soft clay or mud. Indications of a movement in the clays were first seen on the evening of the 6th of May in a small hollow in the bank down which a trickling stream ran, but no attention was paid to it. Up till the hour when the landslip actually commenced, the people who lived on the ground that was swept away crossed it by the highway and went in and out of their houses without any thought of the impending catastrophe. About five o'clock on the

* Trans. Roy. Soc. of Canada, vol. XII. 1894, p. 63.

† The Railroad Gazette, New York, U.S., June 29, 1894.

morning of the 7th, the breaking away of the clay beds began where some slipping had been noticed on the previous evening. Very soon the movement seemed to gather force and work backward through the drier and harder clay in the immediate bank of the river, inside of which it expanded on both sides into the terrace. The softer material flowed out from beneath, while the upper and more coherent clay split off in vertical sheets and columns which were borne away in the sliding, surging mass. This continued for upwards of three hours, when the transporting power seemed to have spent itself, and great masses of clay which had become detached from the walls of the chasm stranded in its bottom, and at the time of my examination were seen standing in various positions, some of them resembling cones, pyramids, etc.

Character of deposits.

The marine deposits in which this landslip occurred are quite arenaceous and silty, especially in the upper part, and no well-defined break was seen to exist between the Saxicava sand and Leda clay, the one graduating into the other. Hence the surface waters percolate downwards to a considerable depth during the period of snow-melting every season. According to the following analysis of three samples of the clay taken from this pit in the laboratory of the Geological Survey, by Mr. R. A. A. Johnston, it was found capable of carrying, when saturated, from 22 to 25 per cent of its own weight of water.

It appears also form the observations taken at the Meteorological station at Quebec, furnished by Mr. R. F. Stupart of the Meteorological Service, that during the winter of 1897-98, the snowfall was heavy, particularly in the month of February, with more than the usual amount of rainfall in May, the precipitation for February exceeding the average for twenty-four years by 2·00 inches, and for the month of May by 0·39 inches.

Rain and snowfall.

TABLE giving the Rain and Snowfall, also the total Precipitation for the undermentioned Months at the City of Quebec.

—	1897.		1898.				
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
Rainfall in inches	2·07	1·15	0·00	0·70	2·42	1·10	3·55
Snow in inches	12·7	12·2	31·5	44·2	3·0	2·0	0·0
Difference from average snow of 24 years	— 5·2	—16·7	— 1·4	+17·9	—19·9	—7·0	—1·0
Total precipitation	3·34	2·37	3·15	5·12	2·72	1·30	3·55
Difference from average total ppn. of 24 years	— 0.52	— 1·45	— 0·97	+ 2·00	— 0·48	—0·93	+0·39

VIEW OF SURFACE OF DEPRESSION CAUSED BY LAND-SLIDE, LOOKING TOWARD OUTLET.

Analysis.

CLAYS from site of Landslide on the Rivière Blanche, a tributary of the Ste. Anne de la Perade, Portneuf county, Province of Quebec.

No.	Clay from	Specific gravity.	Weight of one cubic foot.	Composition.			Absorbtive power.*	Water absorbed by one cubic foot.	Percent of water in saturated clay.
				Argillaceous matter.	Silt.†	Water at 100 C.			
			Lbs.				Percent.	Lbs.	
1	Bank on north side of pit..................	1·923	120·2	47·3	32·4	20·3	2·5	3·0	22·2
2	Bank on east side of pit....................	1·904	119·0	32·3	44·9	22·8	0·2	0·2	22·9
3	Upper clay on north side of neck or opening.	1·911	119·4	27·0	52·7	20·3	7·0	8·4	25·5

* Namely amount of water absorbed in addition to that already contained in it.

† Silt of clay No. 1 consisted of finely divided quartz and felspar with some minute scales of mica and a few particles of magnetite.
" No. 2 " " " " " calcite and magnetite.
" No. 3 " " " " " magnetite.

N.B.—Experiments conducted by Mr. R. A. A. Johnston.

This excess of water passing into the silty and arenaceous clay and sand must have given the beds greatly increased weight. It is probable also that a zone or layer of softened clay of some thickness was thus produced beneath the arenaceous strata, and held in by an impermeable hardpan below, and by the hardened clay banks on the riverward side and on the north, where a depression exists, supposed to be the seat of an ancient landslip. The depression referred to was noted by Dr. Dawson, on the occasion of his visit to St. Thuribe. The walls are now broken down and the inequalities which must have once been in the bottom reduced. This pit appears to have had very nearly the same dimensions as those of the recent landslip, with a similar narrow outlet in the river's bank through which the material was doubtless discharged into the Blanche valley.

Old landslip at St. Thuribe

In a paper read before the Geological Society of America at the meeting held in New York in December, 1898, Dr. Dawson presented the principal facts respecting the Rivière Blanche landslip, with illustrations, under the title of a "Remarkable Landslip in Portneuf county, Quebec," and briefly described those landslips which had previously occurred in this part of the St. Lawrence valley. This paper was published by the Society.*

Mgr. Laflamme, of Laval University, Quebec, also examined the Rivière Blanche landslip, subsequent to the date of my visit, and reported the result to the Commissioner of Colonization and Mines, for the province of Quebec.† He states that an absolutely similar phenomenon happened two or three years ago in the parish of St. Luc, Champlain county, along the Champlain River. As at St. Thuribe, a considerable volume of clay issued through a narrow opening, covered rich alluvial surfaces and blocked the river. Nevertheless the phenomenon at St. Luc was on a very much smaller scale.'

Landslip at St. Luc.

The causes of the Rivière Blanche and other landslips of this part of the St. Lawrence valley seem to be :— (1) the silty and arenaceous character of the Leda clay, rendering it capable of absorbing and retaining a large amount of water, and (2) the increased precipitation during the seasons when these landslips occurred, which saturated the deposits and gave them greater weight than usual. These conditions doubtless produced unstable equilibrium of the beds, resulting in displacement and a flow of the semi-liquid portion. The more coherent clays, breaking down as described, and mixing with the soft material, produced a tumultuous mass of mud, clay and sand, which descended into the nearest valley.

Probable causes of landslips.

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* Bulletin Geol. Soc. Am. vol. X, 1899, pp. 484-490.

†Report of the Commissioner of Colonization and Mines for 1898, p. 131.

UMIAK OR WOMEN'S BOAT, WAKEHAM BAY.

A. P. Low.—Photo. 1897.

ESKIMO IN KYAKS, WAKEHAM BAY.

GEOLOGICAL SURVEY OF CANADA

G. M. DAWSON, C.M.G., LL.D., F.R.S., Director

REPORT

ON AN

EXPLORATION OF PART

OF THE

SOUTH SHORE OF HUDSON STRAIT

AND OF

UNGAVA BAY

BY

A. P. LOW, B.Ap.Sc.

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST
EXCELLENT MAJESTY
1899

No. 680.

G. M. Dawson, C.M.G., LL.D., F.R.S.,

Director Geological Survey of Canada.

Sir,—I herewith beg to submit my report on the exploration in the summer of 1897, of a part of the south shore of Hudson Strait and of the west and south shores of Ungava Bay.

I have the honour to be, Sir,

Your obedient servant,

A. P. LOW.

Ottawa, June 16th, 1898.

NOTE.—*The bearings in this report are all referred to the true meridian, and the elevations to mean sea-level.*

REPORT

ON AN

EXPLORATION OF PART OF THE SOUTH SHORE OF HUDSON STRAIT AND OF UNGAVA BAY.

Introductory.

This report is based on the observations made during July and August, 1897, on the geology and physical geography of the northern portion of the Labrador Peninsula bordering on Hudson Strait and of Ungava Bay. The area examined extended from Douglas Harbour, situated some 150 miles to the eastward of Cape Wolstenholme at the entrance of Hudson Bay, to George River in the south-east part of Ungava Bay, a distance by the coast of 750 miles. The work was chiefly confined to the coast, and except by a few trips extending a short distance inland, the interior was explored only along the lower portions of the larger rivers. Payne River was ascended thirty-five miles, Koksoak River thirty miles, Whale River ten miles and George River twenty-five miles. Mr. G. A. Young. B.Ap.Sc., who had acted as my assistant during the previous season, again took charge of the topographical work, and, in addition, kept daily meteorological observations and made a collection of plants found growing along the coast. He proved most efficient and materially assisted in the success of the exploration. The rest of the party consisted of D. Burgoyne sailing-master and carpenter, J. Lantz, cook, and J. Greenland, sailor, all of whom filled their positions in a satisfactory manner. It had been expected that an Eskimo interpreter would have been secured on the Labrador coast, so that advantage might have been taken of the local knowledge of the natives met with, but heavy pack-ice completely blocked the Atlantic coast on our way northward, and prevented the ship from calling at any place where such an interpreter might have been obtained. As a consequence, we were unable to communicate intelligibly with the natives and doubtless missed much valuable information.

Area included in Report.

Members of the party.

Acknowledgments are due to Mr. C. C. Chipman, Commissioner of the Hudson's Bay Company, for a circular letter to the officers in charge of the several posts visited, and to Mr. Mathewson, Fort Chimo,

Acknowledgments.

Mr. John Ford, George River, and Mr. J. Edmunds, Whale River' officers of the Company, for kind hospitality and help ; also to Capt. A. Gray, of the Hudson's Bay Company's steamship *Erik*, for transporting the yacht and equipment to Nachvak and carefully storing it there for future use.

Investigations in Hudson Strait.

The Parliament of Canada, during the session of 1897, voted a sum of money to send a suitable ship to Hudson Strait in order to further test the period during which the strait is open to navigation. For this work the *Diana*, a Newfoundland sealing steamship, built specially for work in heavy ice, was chartered and placed under the command of Commander W. Wakeham, of the Department of Marine and Fisheries, the remainder of the officers and crew being natives of Newfoundland, accustomed to ice work. Advantage was taken of the transport afforded by the *Diana* to send two parties from the Geological Survey to explore the coast-line of both sides of the strait. Dr Bell was appointed in charge of the party on the north side, and to the writer was assigned the exploration of the southern shore. Two small yachts were built at Mahone Bay, Nova Scotia, for the use of the exploration parties. Their dimensions were similar, i.e., length 35 feet ; beam 10 feet ; extreme draught $3\frac{1}{2}$ feet ; thickness of planking 1 inch, white pine. They were decked over, except a large water-tight cockpit, and below deck had accommodation for two in a small cabin aft, while forward of a bulkhead was a store-room and a small galley, with close accommodation for four men in the bow. Sixty gallons of mineral oil was carried for fuel, in tanks under the seats of the cockpit, and a double burner Primus oil stove was used in the galley, answering its purpose admirably. The yachts were given a yawl rig, with a total sail area of 800 square-feet, sufficient to drive them along in light winds, and provided with wide reefs by which sail was easily reduced in heavy weather. A sixteen-foot skiff was towed as a tender, and was found very useful in landing along the coast. The yachts were found well adapted to the work, except that the pine planking was too soft and thin for rough usage amongst ice; and if the boats are again employed for similar work it would be advisable to sheath them with copper protected by longitudinal battens of hard-wood.

Yachts used in explorations of Hudson Strait.

The yachts were placed on board the *Diana* at Halifax, securely lashed to the deck amidships, leaving only a narrow passage way between them, and were unfortunately the cause of much inconvenience, on board, especially when coal was being shifted from the main hatch to the bunkers.

The *Diana* sailed from Halifax on June 3rd, and passed through the Strait of Belle Isle, where the first heavy ice was encountered. On the way northward along the Atlantic coast, more or less delay was occasioned by the heavy pack drifting southward, and the eastern entrance of Hudson Strait was not reached until the 22nd of June. Further delays by ice, especially in the neighbourhood of Big Island, near the middle of the strait, prevented the *Diana* from passing into the open water of Hudson Bay until the 12th of July. Returning immediately, an attempt was made to land Dr. Bell's party in the vicinity of King Cape on the eastern side of the mouth of Fox Channel, but owing to the great quantity of heavy ice about Salisbury and Nottingham islands and to the northward, it was found impossible to do so, and the ship was headed east, to land my party at the first convenient place on the southern shore. Passage from Halifax to Hudson Strait.

Commander Wakeham, in his report of the voyage of the *Diana**, enters fully into the conditions and nature of the ice of Hudson Strait. My own observations and conclusions in regard to the ice coincide with those so ably set forth by him, and, consequently, it is unnecessary to allude further to them here.

PHYSICAL FEATURES OF THE SOUTH COAST OF HUDSON STRAIT.

Early on the morning of the 16th of July, the *Diana* reached the western entrance of King George Sound, and steamed slowly in between several islands and the mainland. The largest island is about six miles long by about three wide and had been poetically named the Maiden's Paps by some ancient navigator, from the outline of two rounded hills upon it; the other islands are much smaller, but all are high and rocky, the highest points on the large island being estimated at 700 feet above the sea. The mainland is also high, rocky and destitute of trees. It is broken by bold points into small irregular bays, with deep water close in shore, the only danger being due to the lumpy nature of the bottom, which in places rises into small islands, and in others to shoals indicated only by grounded ice. We anchored in a small cove on the west side of the mouth of a deep inlet, about five miles south of the western end of the Maiden's Paps, and a boat was sent to sound the channel into the inlet where a safer anchorage was sought, as the cove where the ship lay was open to the northward and full of ice drifting backward and forward with the tides. During the absence of the boat, preparations King George Sound.

* Report of the Expedition to Hudson Strait, etc., Marine and Fisheries Department, 1897, pp. 61-69.

were made for launching our yacht, and, owing to the absence of yards on the mainmast, considerably difficulty was experienced; but after two hours' work a successful launch was made and as the yacht took the water we named her the *Alle* after the hardy little auk.

Good ship anchorage.

The boat returned in the afternoon and reported a safe anchorage about five miles farther up the inlet, with the shallowest soundings of five fathoms at low-water on a bar at the entrance, and elsewhere from ten to fifteen fathoms. The ship then shifted to the inner harbour, towing the yacht with her, and a good holding ground of mud and boulders was found within a quarter of a mile of the shore on the west side of the bay. Four small rocky islands at the mouth of the inlet practically make the harbour land-locked. The best entrance is between the first and second islands from the west shore, and there is probably a sufficient depth of water for large ships between the other islands, but a narrow bar of large boulders, covered at high-water, extends from the western island to the mainland. The inlet was named Douglas Harbour by Commander Wakeham, and it was subsequently found to be seventeen miles long, being divided into two narrow arms nine miles above the entrance. The main body varies from half a mile to a mile across. High hills rise abruptly from the water almost everywhere, with an altitude of about 700 feet near the entrance, increasing to 1500 feet towards the head of the arms. The next day was employed in rigging the yacht and in stowing the provisions and outfit. Much annoyance was caused by large cakes of heavy ice drifting about on the tide, which required constant watch to keep them from fouling the yacht tied to the side of the *Diana*. In the evening Commander Wakeham handed me a letter containing instructions to be at Fort Chimo on September 15th, when the *Diana* would call there for our party and take us to St. John's, Newfoundland.

Douglas Harbour.

Diana sails.

On Sunday July 18th, everything being properly stowed and the *Alle* completely rigged, we left the ship after breakfast and sailed with a strongly westerly breeze up the south-west arm. The *Diana* shortly after hoisted anchor and stood out of the harbour on her way to Big Island, where Dr. Bell's party was to be landed. We anchored at the head of the arm early in the afternoon and took a series of observation on the sun with the sextant and chronometer for latitude azimuth and time; later, the press was filled with arctic flowering plants which formed a brilliant carpet over the sandy and gravelly terraces in a continuation of the valley of the arm. A small river empties into the head of the arm, and at high-water its mouth was filled with trout from

WEST ARM, DOUGLAS HARBOUR, HUDSON STRAIT.

A. P. LOW.—Photo. 1897.

RAVINE ON BROOK AT HEAD OF WEST ARM DOUGLAS HARBOUR.

one to five pounds in weight. We had unfortunately omitted to bring a net, and as the fish were feeding on swarms of sand-shrimps they would not take other bait freely, so we caught only a few small ones. They proved to be the arctic trout or Hearne's salmon, quite distinct from the ordinary sea-trout of more southern waters. They are abundant in the tidal waters of all the rivers flowing into Hudson Strait and Ungava Bay. In the Koksoak River they have been taken up to fourteen pounds in weight, but ordinarily weigh from three to eight pounds. The bottom, in the shallow water at the head of the arm, was covered with numerous dead crabs of all sizes up to six inches diameter, which had been killed by the weight of heavy cakes of ice grounded there at high-water and left by the retreating tide. Arctic Trout.

Early the next morning an exploration of the country about the head of the arm was made. For a mile, our way led over a level terrace of sand and gravel, one hundred feet above sea level, to where the river divided into two equal branches. The valley of the stream from the sea to the forks varies from fifty to one hundred yards in width, and is cut into the terrace; its grade is steep and the stream in consequence is a continuous rapid over a winding, bouldery bed. The bank of the west branch was followed about half a mile, rising over terraces of thirty-seven and ten feet; crossing the stream further ascents of forty-five and one hundred and twenty feet brought us to the top of a well marked gravel terrace 313 feet above the sea, while behind it and flanking the steep rocky hills, were two other terraces at 375 feet and 506 feet respectively, above sea-level. These are not so clearly defined as the lower ones and are formed of coarser material with scattered boulders, but their tops appear to have been levelled by water, and they probably mark the extreme uplift of the land since the later-glacial subsidence. The stream has cleared the drift from its channel and rushes down a narrow rocky gulch in a beautiful cascade of 500 feet. Above this fall and below the next, there is a fine deep pool in which a number of large trout were seen, but having no means of catching them we could not tell the species, although they resembled the ordinary brook trout. From the pool, a steep climb of 850 feet over well glaciated, granitic rocks, led to a more gradual slope of the upper part of the hill, which was covered with innumerable boulders and blocks to its summit, 1,860 feet above the sea. The view from the summit is very desolate. Barren, rocky or boulder-covered hills on all sides, run in low rounded ridges separated from one another by small deep valleys filled with snow; the surface, wherever there is sufficient soil, was covered with lichens diversified with a few arctic flowers, but not in the beautiful abundance met with in the valleys. No trees and very little soil hide the bare rocks, scarred

Country about Douglas Harbour.

Brook Trout

everywhere with huge blocks and boulders. A few birds, mostly snow buntings and Lapland longspurs were seen on the summit, evidently with young. Having examined the rocks and taken a number of photographs we returned to the yacht in time for a noon observation of the sun, and later on made observations for time to determine the rate of the chronometer. Towards evening it rained heavily and the weather remained dirty all night. The following morning we left the head of the arm and on the way down examined the rocks at several places on both sides. We then sailed to within a mile of the head of the south-east arm, where the water was only two fathoms deep at high-tide. The valley of this arm continues some miles beyond the sea, and is occupied by a large stream which has brought down the sand that forms the wide shoals at its mouth. An observation for latitude was taken at the edge of the shoal water, after which the whole afternoon was spent beating down the arm against a strong wind, the bay being covered with large cakes of ice blown into it by the wind. We anchored in a small cove on the west side, about a mile up the south-west arm, where there was good shelter from the ice. The hills about the head of the south-east arm appear to be higher than those ascended, the highest summits being probably about 2,000 feet above the sea.

Birds.

Floating ice.

It blew a gale during the night, and the wind continued so strong next day that we were unable to leave the anchorage, so Young and I climbed the prominent hill at the entrance to the arm. Its summit, by the aneroid, has an elevation of 1,600 feet, and consists of an immense dyke of rusty amphibolite. We experienced considerable difficulty in walking against the wind and several times had to take shelter behind large boulders during the more violent gusts. During the gale, a peculiar dark cloud remained stationary over the bay. A grand view of the entrance to Douglas Harbour was obtained from the summit, and also of the islands of King George Sound, while on the horizon Big Island was distinctly seen. Stringers of ice were observed in the sound, but beyond it clear water extended for fifteen miles, followed by loose pack to the horizon. On the way up and down the hill several new species of plants and three species of butterflies were added to the collection. Bird life is by no means abundant on the land the only species noted being the snow bunting, Lapland longspur, shore lark, a sparrow, raven and rock ptarmigan, the last still in about half-winter plumage.

Ice in Strait.

On July 22nd, the wind moderated slightly towards morning, and we sailed for the mouth of the harbour under reefed jib only, and racing along with numerous small water-spouts soon reached the

islands at the entrance, where a landing was made. Outside the harbour the wind was steadier and lighter, gradually dying out and leaving us becalmed at noon near the western end of Prince of Wales Island. The distance between the mouths of Douglas Harbour and Fisher Bay is twenty-five miles, and the general trend is east-south-east. The coast between the bays is bold, and indented only by small coves, none of which afford harbours. The rocky shores rise abruptly, from 400 feet to 800 feet above the water, and are backed by higher hills that reach altitudes of 1,500 feet and more. The water appears to be deep close in shore, and only two small rocky islands were seen under the land. The islands to the eastward of the Maiden's Paps, four or five in number, extend in that direction about eight miles; they are much lower than the large island, and lie about ten miles off the coast. From the most easterly island there is an interval of eight miles to the west point of Prince of Wales Island. This island is about six miles long by three wide; it is high and rocky and lies diagonally to the coast, its south-west end being about four miles from the mainland. A smaller, high, rocky island lies immediately off the south-west point, and further eastward three rocky islands partly obstruct the channel between the large island and the mainland.

Coast between Douglas Harbour and Fisher Bay.

Fisher Bay is nine miles long and three miles wide at its mouth, being divided into two arms about half-way up. The bay opens to the north-east, and its western side is quite shallow, extensive boulder-covered flats being exposed at low-water on that side; but there is a good channel along the east side, which leads to a protected harbour behind two high islands near the head of the eastern arm, where we arrived at midnight. Prince of Wales Island is a favourite breeding ground for sea-pigeons, *Cepphus mandtii*, thousands of which were about the yacht while we were becalmed off the island.

Fisher Bay.

The early part of the next morning was spent visiting the mainland and islands at the head of the bay. A small stream falls in from the eastward near the head of the bay, being the discharge of a beautifully clear lake lying between high hills, which the Eskimos report is well-stocked with trout. We ran several lines of soundings through the harbour and the approach to it, and found from five to eight fathoms at low-water.

Towards noon we sailed to the east point, where five families of Eskimos were encamped, engaged in harpooning white porpoises and seals for their winter's supply of oil. The encampment consisted of five seal-skin tents situated on the side of a rocky hill, covered in places with coarse shingle; the tents were erected among the boulders, and

Eskimo encampment.

the only protection from the uneven rocky floor was a pile of hairy deerskins forming the bed in the back part of the tent. Blubber and meat were strewn about the tents indiscriminately, inside and out, and the smell of rancid oil and flesh was almost overpowering. The natives were all clothed in garments of deer-skin or seal-skin dressed with the hair on, and as most of them had apparently been worn a considerable time, they were far from clean. No articles of European manufacture were noticed, beyond guns, rifles, some iron in the spears and a few knives. Few of these people ever come in direct contact with the whites, as they send their winter hunt of furs by some picked men in the spring to Fort Chimo, the journey being made overland with dog-teams and occupying nearly three months. The skins of arctic foxes, bears and wolves are exchanged for guns, ammunition, needles and knives, while any credit remaining is used to purchase tobacco. The hunt had already gone to Fort Chimo before our arrival and as we did not want oil or sealskins, there was very little to trade with and what we did buy was all paid for in tobacco, of which these people are inordinately fond. We took several photographs of the group and also of the tents, and in exchange made a small present of tobacco to each man, woman and child. It was curious to see a mother take a short black pipe filled with rank, black tobacco, out of her mouth and pass it backwards to the small child in her hood; the youngster evidently relished it, as there was always a cry when the mother resumed her own smoke.

Coast between Fisher and Wakeham bays.

Having taken a noon observation on the sun, we stood eastward along the coast to the next large inlet, called Wakeham Bay, and ascended it to its head, arriving there at 10 p.m. The distance, from the eastern side of Fisher Bay to the entrance of Wakeham Bay, is eight miles. The coast between these bays is more rugged and broken than to the westward, with a few small islands along shore but no shelter sufficient for the yacht. The land rises abruptly from the shore and increases in altitude as Wakeham Bay is approached, where, on the east side of the entrance, a rounded hill rises 1,800 feet directly from the water, and must be a prominent mark from far to seaward; the other hills along this part of the coast vary in altitude from 800 feet to 1,500 feet.

Wakeham Bay.

Wakeham Bay is twenty miles long. At its mouth it is nearly two miles and a half wide, gradually narrowing to a little over a mile about three miles above the entrance. The water of the approach is deep, and the only obstructions to free navigation are two small islands, nearly covered at high-tide, one of which lies about two miles north-

east of the western head and the other about three miles due north of the eastern side of the entrance. There is plenty of room between them, and they should not be dangerous in approaching this, the safest and best harbour on the south coast of Hudson Strait. The eastern side of the entrance is formed by a rocky peninsula 600 feet high, joined to the mainland by a neck of sand and clay less than fifty feet high, with a small lake in the middle. Beyond the narrows the bay averages three miles in width for ten miles; the remainder of the upper end being less than a mile wide. A fine protected ship harbour, out of the run of the tide and consequently free from the danger of quickly moving ice, was found just inside the peninsula, with good anchorage in from fifteen to twenty-five fathoms opposite the low sandy neck. Of course when the bay is full of ice, a ship would be beset here, but there is no current in the cove and consequently the ice-pressure would be due only to wind. Excellent ship harbour.

The highlands on the west side continue about ten miles up the bay to the wide valley of a small stream, beyond which the immediate hills vary from 200 feet to 500 feet until near the head of the inlet, when they reach heights of 1,200 or 1,500 feet. On the east side, the general altitude of the hills ranges from 800 feet to 1,000 feet, and there are numerous wide, drift-filled valleys below the 300 foot level.

On July 24th, the yacht remained at anchor all day, and we busied ourselves examining the country and rocks about the head of the bay. The main valley continues a long distance inland, and is occupied by a small unnavigable river. Other wide valleys parallel to that of the inlet make the country more broken, but lower than that described about the head of Douglas Harbour. The hills are from 1,000 feet to 1,500 feet high, and being formed from diabase and schists are more abrupt in outline than those of the granite region to the westward. In the afternoon we examined the lower stretches of the river with the small boat, and later dredged from the yacht, securing a number of crabs and shrimps, which, with other dredgings taken later were preserved in alcohol, and given to Commander Wakeham. Two of the men went hunting, and although they saw many tracks of caribou, they did not come across any of the animals. Head of Wakeham Bay. Dredgings.

The next morning we beat down the inlet against a light head wind and reached the anchorage behind the peninsula at 1.30 p.m. The last five miles was made through large cakes of heavy ice, which the wind was rapidly drifting into the bay. This was exciting and somewhat dangerous work, as our boat with its inch planking would not

stand many hard knocks or pinches, and several times we had to force passages between large pans. From the summit of the peninsula the coast was found to be tightly packed with ice, while a constant heavy stream of it was pressing through the narrows into the bay As the cove in which the yacht was anchored still remained free from ice we determined to remain there. Later in the evening a family of Eskimos was found encamped on a point outside the bay.

Delayed by ice.

On July 26th, the wind continued from the north-east, causing the stream of ice to rapidly fill the bay with each flood tide, while little if any went out with the ebb;a circumstance probably due to thelarge body of ice outside preventing the rapidly flowing tide from carrying out the ice brought in on the preceding floods. In the morning we sounded the bottom of the open cove, where we were hemmed in, with the results previously stated; and then dredged, obtaining several species of shells, crabs, sea-urchin, shrimps, sponge, rock-cod and a sculpin. As the ice was encroaching on the yacht we beached her near high-water mark on a bed of gravel out of reach of the heavy cakes of ice which took the ground in much deeper water outside. In the afternoon we climbed the hills on the east side of the bay and obtained the barometric elevations of the terraces on the peninsula. We gave the Eskimo a rifle and sent him for caribou which he says are plentiful not far away. The following day the conditions remained the same, the ice pouring into the bay with the north-east wind. On the 28th the bay was full of ice, and fearing that a change of wind might block us in the cove for days we took the yacht in tow of the small boat and succeeded in moving her along shore about a mile, to the point at the narrows, where we were caught in the ice moving in contrary directions with the current and eddies and only with great good luck escaped serious damage. Being unable to pass the point we returned to our former anchorage, where we remained until the evening of the next day, when we again tried to tow out of the bay and succeeded in passing the point on the slack water at high-tide, and then took the yacht into a small cove on the outer side of the neck where we were icebound until August 1st. During our enforced delay, the time was employed examining the surrounding country and rocks and in painting and cleaning the yacht. On the last day we were visited by a large party of Eskimos in three umiaks and seven kyaks. They were on their way from Stupart Bay to some place on the coast to the westward where they go inland to hunt caribou for their winter's supply of clothing. I took several photographs of the boats and people and made to all the customary present of a small piece of tobacco.

Eskimo visitors.

We started as soon as the yacht floated on August 1st and had considerable difficulty working out of the cove between the large pans of ice aground; when outside a light west wind carried us past Cape Prince of Wales to Stupart Bay where we anchored for the night. The course all the way was through loose ice, sufficiently open to allow the yacht to pass with little danger.

The distance from Wakeham Bay to Cape Prince of Wales is twenty-four miles and the course is nearly east. A large island, which we called Doctor Island, lies about three miles off the coast, with its western end about fifteen miles from Wakeham Bay. Doctor Island is about five miles long and appears to be triangular in shape; it is much lower than the large islands to the westward, and from outside might be taken for a portion of the mainland. The coast is more indented than to the westward, but all the bays are wide and afford no shelter from northerly winds. The hills, for ten miles beyond Wakeham Bay, rise about 800 feet directly from the sea; they then become lower and less abrupt, and are broken by wide valleys, in which the drift is terraced to about 300 feet above the present sea-level. As Cape Prince of Wales is approached the hills gradually die out and about the cape do not exceed 300 feet in elevation. With the decrease in the height of the land there is a corresponding shallowing of the water, and to the eastward of Doctor Island there are numerous shoals, some of which are bare at low water and others marked by heavy ice grounded upon them.

Wakeham Bay to Cape Prince of Wales.

Shallow water.

From Cape Prince of Wales, the course was south for five miles, to the entrance of Stupart Bay, where one of the government observation stations was situated in 1885-86. We found the dwelling-house still standing and in good repair, the other buildings having been broken up by the Eskimos. The house was closed with large blocks of cement from the pillars for the magnetic instruments. The inside of the house is used by the natives as a store-house for oil and the floor was covered with sealskins full of oil, the stench of which was overpowering. One room had been left locked by Mr. Payne, the observer, and the natives had never entered it, as we found, among other things, on forcing the door, a small mirror, two tin pails and some boots, all of which were of great value to these people. This is a proof that the Eskimos of the south side of Hudson Strait have not the thieving proclivities reported of the natives in other parts of the Arctic, and our own experience was wholly corroborative, for although no watch was kept of them while aboard the yacht none of the small articles lying about were ever missed.

Old observation station at Stupart Bay.

We left Stupart Bay early next morning with a light south wind, that freshened to a strong breeze, and sailed across Joy Bay to the south of Stupart Bay and up its south shore into very shallow water, with eight feet about a mile from the shore at high-tide. The head of the bay is blocked with sand brought down by the small river emptying into it. We were unable to enter the river on account of the sandy flats at its mouth, but it appeared larger than any stream yet passed, and the deep valley in which it flowed was flanked by sand terraces up to 200 feet.

Joy Bay.

This is probably the river in which the Eskimos are reported to have caught salmon and trout for the observation station. From the bottom of Joy Bay we beat out to near the end of the point separating it from Whitley Bay, and came to anchor in a good boat-harbour behind an island, being unable to proceed further on account of thick fog, rain and loose ice.

Joy Bay is nine miles wide and about the same in depth. Its shores are generally low, and greatly broken by rocky points, forming shallow irregular coves; a number of rocky islands are dotted over its surface. The water is nowhere deep and the bottom is irregular, so that it would be dangerous to enter with a vessel. The country in rear is broken, and the hills vary in altitude from 300 feet to 700 feet, but they rise more gradually than those along the coast to the westward, and appear to run in ridges parallel to the strike of the rocks, or north-west and south-east, with abrupt cliffs towards the south-west.

The rain and fog continued until 3 p.m. the next day, when a light southerly breeze enabled us to get into Whitley Bay, where we grounded for two hours, and finally made a harbour at dark in the upper end of the bay some eight miles from the point, and just outside a narrows between high rocky cliffs where the tide rushed through at a rate of seven or eight knots an hour. Whitley Bay is even more shallow than the last, and like it completely dry at low-tide, when the bottom shows as mud-flats covered with many great boulders. Eider ducks in thousands feed on these shoals.

Whitley Bay.

The following morning we landed Young on the west side of the narrows to sketch the adjacent coast from the summit of the hill, which he found to be 700 feet high. We then sailed through the narrows on the rising tide which caused a heavy rapid with a fall of three feet in fifty. Beyond the narrows, the bay widens to about a mile across and continues with this width for two miles, to its head, where a small river flows in through a deep narrow valley. On our way out we had considerable difficulty in stemming the rapid with a strong fair wind, and only

A. P. Low.--Photo. 1897.

GROUP OF ESKIMO AT WAKEHAM BAY.

succeeded in doing so by crossing from side to side and so taking advantage of small eddies. Picking up Young at the point, we sailed into the next small bay, which is navigable only at high-tide; and remained there examining the rocks until after the noon observation for latitude.

We then ran eastward along the coast behind a large island and past several small bays open to the north and north-east, and anchored in a deep narrow inlet about three miles long, with a small river flowing in at its head, thirty miles from Whitley Bay. This is an excellent boat-harbour, but very deep, there being seven fathoms of water within a hundred feet of the shore. We saw only a few strings of loose ice about ten miles off shore. Last ice seen.

After passing the large island, five miles long, at the mouth of Whitley Bay, the coast again becomes bold, with deep water close in shore and with only a few small islands under the land. The hills rise abruptly from 400 feet to 1,000 feet above the sea, and there are only small areas of terraced drift at the heads of the bays and coves and in the valleys between the hills; elsewhere only bare rock is seen.

On August 5th, we made only eleven miles on account of calms and very light winds. The coast passed was more rugged, with the hills rising directly from the water to heights varying from 700 to 1,000 feet. No good harbours were seen, but the coast is indented with small coves, all open to the sea, and without islands or points with shelter behind them. There are drift terraces in all the bays, and we measured a series of eight on the flank of a conspicuous headland called Dyke Head. No ice was seen during the day, but there was an ice-blink to the north-east and a patch of fog to the eastward. The next day we had no wind until evening, when we ran until dark in search of a harbour, and found only an indifferent one behind a point near the head of a bay, open to the north-east, twelve miles east of our last anchorage. The coast passed was broken by three bays, the first being broad and the last two about five miles long and from one to two miles wide, with deep water to their heads and no safe anchorage from northerly wind. The coast continues bold, with sharp headlands about 1,000 feet high jutting out between the bays. Coast east of Whitley Bay.

We remained at anchor for the next two days, riding out a heavy north-east gale in a partly exposed position, where the yacht was subjected to the force of the heavy swell heaving into the bay from outside. Gale.

On August 9th we left this anchorage, and taking advantage of a strong north-west wind, soon passed eight miles of the same high broken coast, to the mouth of Diana Bay, which is sixteen miles wide Diana Bay.

and nearly twenty-five miles long. The western shore is high and rocky, but about the head of the bay and along the east side, the country is much lower, the highest hills not having an elevation of more than 200 feet; in the south-east corner, the general level is below 100 feet. The mouth of the bay is blocked by a high island about eight miles wide and extending eleven miles up the bay; good shelter for ships could be found among several other large islands that lie between the big island and the west shore. The head and eastern part of the bay are shallow with a lumpy bottom of rock and boulders.

Errors of the Chart.

This portion of the coast is not accurately mapped on the chart, there being two large islands marked at the entrance to Ungava Bay and no bay like the one here described. As the coast on the chart was laid down from observations made on ships sailing through the strait, it is very likely that the large island in the bay is the inside island shown on the chart, and that the point forming the east side of the bay is represented by the outer island, the land at the head of the bay being below the horizon of a ship passing through the strait. We anchored for the night in a small cove on the east side near the entrance to the bay.

Cape Hopes Advance

The next morning we sailed four miles, with a light wind from the north-east, to Cape Hopes Advance or Prince Henry Foreland, rounding which we proceeded south-east through a labyrinth of small rocky islands with shallow water between them, until we were stopped by thick fog at 3.30 p. m., when we had to feel our way to a harbour, being guided by the lead and by the noise of the breakers. Cape Hopes Advance is about 300 feet high and rises boldly from the water, but beyond it the coast is much lower and the irregular hills rarely exceed 200 feet in altitude. The islands were called the Eider Islands on account of the great numbers of these ducks found nesting upon them.

Thick fog covered the sea all next day, with light winds from south-east to north-west and consequently we were unable to sail. The fog appears to hang nearly constantly about Cape Hopes Advance, a circumstance caused perhaps by warmer currents of water and air from Ungava Bay meeting the colder currents of the strait. There was little fog inland, so we landed and took a series of observations for latitude and azimuth, and later, dredged between the islands, adding to our collection three new small fishes, a sponge, an anemone, a shrimp, some corals, and a few shells. Great quantities of kelp on the bottom seriously interfered with the dredging by blocking up the mouth of the dredge.

On August 12th, we started early and sailed south-southeast eleven miles, between low rocky islands that form a fringe about four miles wide along the coast. The water between the islands is very shallow, so that at low-tide many of them are joined together and to the mainland. Shallow water with shoals appears to extend outside the islands for several miles, rendering an approach with large vessels dangerous. The course was then changed to south-west, and we continued in that direction for twenty-eight miles, and were then forced to ground the yacht at high tide in a small rocky cove at the head of a wide shallow bay, in order to escape the dirty weather brewing with a north-east wind and a very low barometer. The islands gradually die out along this course after about ten miles, but the shallow water continues and the bottom being uneven is very dangerous on account of the great blocks and boulders scattered over it. The coast is low and broken only by detached, irregular hills never over 200 feet high. The country is covered with drift to a considerable extent and the flats are dotted with many small ponds, the breeding place of ducks and wading birds. There are no large streams, the ponds being drained by a network of brooks. Shallow water.

During the night, the wind increased to a gale which continued until the following evening, when it shifted to north-west and the weather cleared. The yacht remained on the beach and we passed the day making excursions over the peaty plains, passing over a hill 200 feet high, faced on both sides with boulders forming a ridge running nearly west inland to another hill about three miles away. The appearance of the bay at low-tide was startling. The bottom was entirely exposed for about three miles outside high-water mark and was formed of low rocky ridges with mud flats between them, while everywhere boulders of all sizes were strewn about. Stormy weather.

The next morning, at high-tide, we towed the yacht out of the bay, but made no headway until afternoon, when we sailed southward about five miles with a very light south-east wind, and then searched for upwards of an hour for a sufficient depth of water to anchor in. We finally found a hole between a number of small drift-covered islands with forty feet of water at high-tide. At half-tide the current between the islands was so strong that the yacht surged to and fro with the helm lashed hard over and we were in danger of breaking adrift, or dashing against the hummocks of boulders which formed the sides of the hole. Fortunately, as the tide became low, the shallows about became dry and the current slackened, so that when the yacht grounded for upwards of an hour it was in quiet water. This is an example of Great rise and fall of tide.

the great rise and fall of the tide in Ungava Bay, and of the danger in navigating its shallow waters, where the tide falls an inch a minute, and where, in consequence, if a boat grounds in falling tide it is impossible to release her until the water rises again. We named the islands in the neighbourhood the Plover Islands, on account of the great flocks of these birds met with here, together with thousands of gulls, sea-pigeons and eider ducks. The coast in the vicinity is low and flat like that previously described, and the shallow water extends several miles out from shore. We saw the loom of a large island some twenty miles to the eastward which we subsequently learned from the Eskimo was the western end of Akpatok Island. This changes the west end of the island thirty miles to the north of its position on the chart, making it conform with the position of the northern and eastern parts as laid down by the *Diana*.

Plover Islands

On August 15th we continued southward for twenty miles, passing among low islands formed of rock and drift, separated from one another and from the low shores by shallow water, and arrived at a rocky headland called Tuvalik, on the north side of Payne Bay. A band of Eskimos in four tents, was found at Tuvalik, and from these people we learned that a large river flowed into the bay. We sailed five miles up the bay, passing with shallow water over muddy flats, and anchored in a deeper channel, off the point at the entrance to a bay stretching to the northward, where it was thought the river might flow in. The coast passed during the day was very similar to that already described, being generally low and flat, broken only by occasional ridges of rocky hills never more than 300 feet high. These have an east-and-west trend, and thus come out to the shore in rocky points. The hills have the aspect of the Cambrian hills of the Koksoak River, and are formed of stratified rocks, the direction of the ridges conforming with the strike of the rocks, which dip northward at low angles and correspond to the hill-slopes in that direction, while towards the south the hills generally have abrupt cliffs.

Eskimos at Payne River.

The next morning we sailed to the head of the northern bay, but there found only a small stream discharging a lake some ten miles long, that lay in a wide valley to the northward. Some time was spent examining the rocks on the mainland and islands, which were found to contain large quantities of iron-ore. In the afternoon we worked out of the bay, (nearly dry at low tide), and anchored for three hours between the islands at its mouth, awaiting the flood-tide to enter the river. In the evening the river was ascended about six miles, on a very strong current, and the yacht was brought to anchor under the

A. P. Low.– Photo. 1897.

VIEW OF PAYNE RIVER, THIRTY MILES ABOVE ITS MOUTH.

north shore in thirteen fathoms of water. After dark we were joined by a number of Eskimos in an umiak and seven kyaks, who pitched three tents on the shore opposite the yacht.

The following morning we visited the encampment and arranged with two men to pilot us up the river. We started on the rising tide under treble reefs and raced up stream ahead of a gale, making over twenty-five miles in less than three hours. There were tremendous tide-rips at an island about fifteen miles up, which we successfully passed through and arrived at a second rapid, where the river is obstructed by a bar of huge boulders stretching diagonally across the stream near the head of tide-water. Beyond this obstruction the river was unnagivable for the yacht. In the afternoon I sent the Eskimos to kill a barren-ground caribou, these animals being plentiful about here, and with Young ascended the hills on the north side of the river, and took several photographs from the summit. Payne River.

The country on both sides of the river is rough and rocky, with hills rising about 600 feet above the stream, and divided into ridges by deep valleys containing small tributaries. The valleys and sides of the hills are generally mantled with clay up to an elevation of 300 feet, while above that there is little fine drift, but plenty of scattered blocks and boulders. The hills are composed of granites, and consequently have the usual rounded aspect due to glaciated masses of this rock in the Laurentian country. The river stretches far to the westward, and about ten miles above the limit of tide the stream divides into two nearly equal branches, each with a deeply cut valley. The climate seems to be less rigorous than along the coast, as the willows grow to bushes several feet high, instead of only rising an inch or two from the ground as on the sea-shore. Country about Payne River.

The following morning an attempt was made to catch salmon and trout with a fly at the foot of the rapid, but without success, although a number of large trout were seen swimming about in the eddies. The Eskimos returned at noon with a part of a very large buck, which had been killed the previous evening; and on their arrival we started down stream. When the island was reached where the heavy tide-rips had been noticed on the previous day, we found that a ledge of rock extended from the island to both shores, causing a rapid with about six feet fall in two hundred yards. It was rather exciting to sail down with the yacht with only sufficient wind for steerage, but we got through safely and continued down stream eight miles, until met by the rising tide, when the anchor was dropped until the next ebb. Salmon and trout.

We got under way at three o'clock next morning and drifted down to the Eskimo encampment, where we paid off our pilots and

landed to photograph the natives. We bought a number of Arctic trout which had been taken in a net, and were informed that the Atlantic salmon were also abundant in the river. The natives were on their way to the caribou-hunting grounds, some fifty miles above where we turned back on the river. They would remain there for a few weeks spearing the barren-ground caribou as they crossed the river in great bands during the autumn migration southwards to the edge of the wooded region.

Barren-ground caribou.

In the afternoon we continued down the river and along the south shore of the bay, coming to anchor among some islands nine miles beyond the south point of the bay.

Payne Bay.

Across its entrance, from Tuvalik to the south point, Payne Bay is fourteen miles wide. It gradually narrows to about three miles at the mouth of the river, which is eleven miles to the westward of Tuvalik. The bay is generally shallow and dotted with islands and bouldery shoals. There appear to be two deep channels leading from the mouth of the river towards the sea, one on either side of a group of five islands about three miles off the mouth. The deep water extends beyond the islands, but outside, in line with the capes, there appeared to be a number of low bars and shoals which practically block the entrance to the river for large vessels.

The river at its mouth is nearly three miles wide, but decreases rapidly to a point projecting from the south shore, three miles up stream, where it is about two-thirds of a mile across. Above the point it again widens, and varies from three-quarters of a mile to a mile and a half, for fifteen miles, to where it takes a sharp bend to the northward, two miles below the first rapid. The bend is a mile long, when the river again flows from the westward for six miles from the head-of-tide rapid. On the lower course the bays are shallow and are generally dry at low tide, presenting mud-flats covered with boulders, these being particularly thick along the outer margin of the flats where they have been shoved up by the ice. A number of shoal points and bars stretch out from both shores and there are also shoals dividing the deep channel of the lower part of the river. These bars and shoals are covered at high-tide and are then very dangerous owing to the large boulders scattered over them. As has been already mentioned, there is a reef of rock extending from shore to shore at the island above the bend, the heavy rapid caused by it is not more than ten feet deep and forms a practical bar to further navigation.

Dangerous entrance to Payne River.

Above the island, the channel appears to be uniformly of good depth for the next six miles, to the second rapid, where a line of boulders

stretches diagonally across the river and at low-tide causes a fall of about six feet over and between the boulders. The Eskimos report shallow water above this rapid, navigable only with small boats and very rapid everywhere, but without any direct fall. The river forks about ten miles above the rapid, and some distance further up the main branch again divides. The middle branch flows out of Payne Lake about a hundred miles to the westward of the mouth of the river, and it is near the outlet of the lake that the Eskimos go for caribou. The volume of the river is estimated to equal that of the Gatineau at Ottawa. The banks above high-water mark are generally rocky, except in the bays, where the drift terraces are faced with dry walls of boulders. The hills on both sides of the valley are continuous except where broken by the valleys of small tributaries; they gradually increase in height from the coast inland, being from 200 feet to 300 feet near the bay and about 600 feet at the upper rapid. There are considerable deposits of clay overlain by sand in the valleys, and these are terraced up to 300 feet above sea-level.

Drainage of the northern interior.

Payne River is the only important stream flowing into Hudson Strait between its mouth and King George Sound, none of the other rivers being sufficiently large to drain an area extending fifty miles inland. From this it would appear that the area along the coast must be higher than the interior portion of northern Labrador, and that the streams flowing into Hudson Strait and the northern part of Ungava Bay only drain a relatively narrow outer slope of coastal hills, the main drainage flowing first southward and then east or west into Ungava and Hudson bays. This is borne out by the description of the interior given by the Eskimos, who say that the country far inland from Payne River and southward is lower and flatter than the highlands of the coast, and that the extensive plains are dotted with lakes and covered with a much better growth of vegetation, affording excellent feeding-grounds for immense herds of caribou.

Low shores and shallow water.

On August 20th, we started at 3 a.m. with a light south-west wind and sailed southward along a low flat coast, being gradually forced off shore by the shallowness of the water, which never exceeded five fathoms and at times was less than three fathoms. For twenty miles we passed between a number of low rocky islands, lying from five to ten miles off the mainland, and arrived opposite a deep bay, about ten miles wide, with a long low point dividing it into two channels each about three miles wide. Highlands were seen about twenty-five miles to the westward, probably near the coast at the head of the bay. Eight miles south of this bay we landed for an observation on a rocky shore, having

isolated hills 200 feet high, but generally low and flat. From there the course was south-southeast for seventeen miles to Cone Island, only 140 feet high, but very conspicuous among the surrounding low islands. We anchored in deep water behind some small islands six miles to the south-east of Cone Island, arriving there at dark.

During the afternoon we followed the low shore on which we had landed for the observation, and were about eight miles off it at Cone Island, from the top of which a large bay with high shores was seen running north-west for about fifteen miles. While looking for a harbour we entered this bay and found it very shallow; it has a couple of smaller bays running northward from its upper end. The Eskimos at Fort Chimo say that this bay connects with the bays passed in the morning, the whole forming Hopes Advance Bay, which is consequently about twenty-fives mile wide at its mouth and about twenty miles deep; this being much less than the length given on the chart. The mouth of the bay is blocked by large islands with shallow channels between them, through which the tides rush in and out with great violence, rendering the bay quite unnavigable for large ships. A river nearly as large as Payne River is reported to flow into the head of Hopes Advance Bay.

Hopes Advance Bay.

Gale.

We passed an uncomfortable night, owing to the strong tide between the islands keeping the yacht broadside to the heavy sea. The wind was fresh in the morning and was accompanied with fog, while the barometer fell steadily and we decided to look for a more sheltered harbour. This was found between the islands and the mainland, but with the tide rushing through the channel like a mill-race. The wind increased to a gale in the afternoon and changed to the northward, forcing us to put out the second anchor. It blew very hard during the next night with heavy squalls of rain, changing to snow during the following afternoon, the hills becoming white while there was about six inches of snow on the deck. In the evening the wind shifted to north-west, and the weather partly cleared. On the morning of August 23rd, we worked for two hours getting up the anchors which had become fouled under boulders by the swinging of the yacht. We then sailed eight miles southward, through a labyrinth of islands which were named Gyrfalcon Islands from the number of those birds seen.

Gyrfalcon Islands.

The islands are formed by broken ridges of stratified rocks; the ridges lie south-east and north-west with which the length of the islands conform. They vary in height from 50 feet to 200 feet, and have cliffs facing the south-west, with more gentle slopes in the opposite direction conforming to the dip of the rocks. The water in

the channels between the ridges is deep, but in the cross channels it is liable to sudden changes and is often shallow. The mainland has the same character as the islands and is so broken by bays that it is very difficult to distinguish coast from islands.

From the southern limit of the islands we crossed a bay. This is called Leaf River Bay, and is about eight miles wide at its mouth, but narrows to three miles across some ten miles up. This we learned was the entrance to Leaf Lake, a body of salt water divided from the bay by a deep narrow strait walled in by high rocky cliffs. A small vessel called the *Fox* is sent annually by the Hudson's Bay Company from Fort Chimo to kill white porpoises in the lake. The captain of the *Fox* estimates the lake to be nearly fifty miles long and about ten miles wide. Its longer axis runs about north-northwest, and the outlet is situated about half-way up the lake. The Leaf River flows in on the west side almost opposite the outlet, and is a considerable stream having a volume about equal to Payne River, according to the estimate of the Eskimos. Salmon are not known to enter this river. Barren-ground caribou are always plentiful on the plains inland along the course of the stream, where willows and arctic birches grow abundantly as large bushes and are the only trees of the region, the northern limit of the spruce and larch being still further south.

Leaf River Bay.

Porpoise fishery

We sailed eastward along the south shore of the bay for twelve miles to Stony Point, where we were obliged to anchor behind a rocky islet in a heavy swell, owing to the wind dying out. The south side of the bay being formed of granitic rock, is totally different in character from the north shore; there is an absence of islands and the water is shallower gradually deepening to about five fathoms a mile off shore. The shores are generally rocky at the small points, and elsewhere boulder-strewn, while the country behind gradually rises into long rounded hills never more than 200 feet high. A thick mantle of drift covers the slopes and fills the valleys, but owing to the gentle slopes the terraces are not well marked and were only indistinctly seen from the yacht. Stony Point is a rocky hill about 200 feet high, with a number of rocky knolls outside, which become islands at high-tide, with huge masses of rock scattered everywhere. The water is very shallow for two miles outside the point, and for five miles beyond the sea breaks upon a number of boulder shoals.

Coast south Leaf River Bay.

On August 24th, we started at 4 a.m. and sailed south-southeast for thirty-five miles along a low and almost unbroken shore to the mouth of the Koksoak or Ungava River. This part of the coast is low, with only three or four islands of shingle close to the shore and separated

Coast north of Koksoak River.

from the mainland by shallow channels dry at low-tide. The water deepens slowly to about five fathoms a mile off shore, and there appears to be very few shoals outside that limit except towards the mouth of the river, where a number of rocky islands and shoals extend outwards from the north point for more than a mile. Other shallow places in the mouth of the river render an entrance hazardous without the aid of a pilot. We stopped at the mouth of the river until 1 p.m., awaiting the rising tide which carried us to Fort Chimo, thirty miles up, where we arrived at 5.30 p.m. and found the Hudson's Bay Company's steamship *Erik* at anchor opposite the fort. She had arrived on August 20th from Churchill, this being the earliest arrival on record.

Arrival at Fort Chimo.

We remained at Fort Chimo until August 27th, making necessary repairs to the yacht and equipment, and then left for George River which empties into the south-east part of Ungava Bay about 100 miles to the eastward of the mouth of the Koksoak. Before leaving, arrangements were made with Captain Gray for the transport on the *Erik* of the yacht and equipment from Fort Chimo to Nachvak on the eastern Labrador coast, where the yacht would be available for another season's work in the Strait or Hudson Bay. This would not have been the case if the yacht had been laid up at Fort Chimo, owing to the impossibility of reaching that place until the end of August, too late for any effective work.

We dropped down the river and anchored in a small cove on the south side near the mouth, where we waited for the next morning tide, which carried us eastward fifteen miles, past a number of low shoals of rock and boulders stretching nearly ten miles off the south point, until we finally brought up against a line of reefs, bare at low tide, that extends northward from the islands at the mouth of Whale River to and beyond a large island called Saiglorsoak, that lies sixteen miles outside. This island is surrounded by a cluster of smaller ones, all high and rocky and forming good marks in stearing for the Koksoak River. Saiglorsoak is about five miles long and should be kept well to the southward as the reefs continue some miles beyond it.

Islands off Whale River.

Whale River.

We turned south along the west side of the shoals and with the rising tide soon reached the channel between Big Island (Whale River) and the mainland. The channel narrows from a width of three miles at its entrance to less than a mile at the upper end of the island, seven miles farther up, where a sharp bend of a mile to the eastward leads to the true mouth of Whale River. The deep part of the channel is quite narrow and is bounded by extensive mud-flats on both sides

that are bare at low-tide. The current in the channel is very swift, and at several places breaks into rapids and tide-rips. At the bend we picked up an Eskimo, who was engaged setting salmon nets for the Hudson's Bay Company, and with him as guide reached the Hudson's Bay post, situated on the east bank eight miles above the mouth of the river, arriving there after dark. The channel up to the post varies from a mile to a mile and a half in width and is full to the banks at high-tide, but at low-tide, bare mud-flats occupy over two-thirds of the width, with the deep channel considerably below their level. The post is situated at the head of navigation, there being shallow rapids only a short distance above it, where the influence of the tide ceases. The river has a volume about equal to that of Payne River and drains a large area of country to the southward, between the drainage-areas of the Koksoak and George rivers. It rises in large lakes about 200 miles inland, on one of which the Hudson's Bay Company formerly had an outpost, mentioned as Erlandson's Lake post in McLean's narrative.* The post at Whale River is merely a fishing establishment and small trading station for the natives in the vicinity, consisting of three small buildings. The salmon fishery in the lower part of the river was formerly a paying industry, but has been gradually decreasing and this year (1897) was almost a total failure, as were the fisheries in the Koksoak and George rivers.

Hudson's Bay Company's post.

The banks of the river are generally low, with terraced drift behind and highlands in rear of the post, where the hills rise about 500 feet and are partly wooded with small black spruce and larch, the woods extending nearly to the mouth of the river.

Coast between Koksoak and Whale rivers

The coast between the mouths of the Koksoak and Whale rivers is generally low, with a range of hills extending from the mouth of the former stream south-east about the head of False River Bay to the mouth of Whale River. There is a shallow bay on the south side of the mouth of the Koksoak, between these hills and the end of a low bouldery point five miles to the north-east of them. Rounding this point, the coast trends to the south of east for ten miles, to the mouth of False River Bay, so called on account of having been often mistaken for the mouth of the Koksoak. This bay is several miles long and about three miles wide at its mouth, but is so shallow that it cannot be navigated even by small craft. A low point separates False River Bay from the west channel to Whale River which has been already described.

* Notes of a Twenty-five years service in the Hudson's Bay Territory, London, 1849,

Coast east of Whale River.

Next morning we left the post on the top of high-water and sailed out by the channel to the east of Big Island which can only be used by small craft at high-tide. Then, with a fair wind, we continued north-east along the coast for forty-five miles and anchored at dark in a small rocky cove quite open to the sea. The coast passed is generally low with an occasional rocky point. The water is very shallow everywhere for two or three miles off, and we were obliged to keep that distance out to avoid striking. There are a few rocky islands scattered along the shore, but they are surrounded by water too shallow to afford harbours behind them. Two long bays were passed, which extend inland between the high hills that rise behind the low margin along shore. The natives say that three small rivers empty into the heads of these bays, one stream flowing into the western bay and two into the eastern. These bays are very shallow and at low-tide are nearly dry and quite unapproachable. The margin of low land varies from one to five miles in width ; beyond it the country consists of rocky hills rising to altitudes varying from 500 to 1000 feet ; the hills are broken by the deep valleys of the rivers mentioned and those of minor streams.

We got under way at four o'clock next morning and arrived at 7 a.m., at Beacon Island on the west side of the mouth of George River, seventeen miles from the starting point. The wind freshened to half a gale, blowing directly out of the river, and in consequence we only made six miles more by 11 o'clock when we were forced to anchor behind a large rocky island on the east side to await the next rising tide. This was the strongest wind in which we had sailed during the season and the tide against the wind raised a heavy short sea. The yacht behaved splendidly, however, working to windward with treble-reefed mainsail and reefed fore-staysail without straining and dry except for the flying spray. We remained behind the island until 4 p.m., and then made about six miles before dark, when we anchored under a point about two miles below the George River Narrows.

The coast from last night's anchorage to Beacon Island is higher and more rocky than to the westward ; it is greatly broken by irregular rocky points, and is fringed with islands. The water unfortunately remains shallow.

We started early on August 31st, and succeeded in getting within a mile of the cove where the Hudson's Bay Company's post is situated before the change of tide. There we anchored until evening, when we worked the yacht into the cove.

The cove is on the east side of the river twenty-three miles from Beacon Island. The post consists of the usual three or four small houses, built on the side of a hill that rises about 700 feet above it. The opposite side of the cove is bounded by a similar hill, and the situation is very desolate, especially at low-tide when the bottom of slimy mud and boulders is bare out to the river a mile away. A few stunted trees grow along the banks of a large brook which flows into the upper part of the cove. The post is kept up chiefly for the salmon fishery and for the trade with about twenty families of Eskimos living along the eastern shore of Ungava Bay. Hudson's Bay Company's post at George River.

The George River is a large stream second only to the Koksoak; it drains a wide area of country to the southward, extending from the western slopes of the Atlantic range to the Whale and Koksoak drainage-areas on the west. It rises in large lakes of central Labrador, in the vicinity of the fifty-fifth parallel of north latitude, close to the head-waters of the North-west and Hamilton rivers which flow eastward into Hamilton Inlet. Beacon Island is the largest of a group lying off the western point at the mouth of the river, and is situated about two miles from Gull Island, which is connected with the shore at low-tide. From Gull Island to the large islands on the east side, the distance is three miles, and this constitutes the width of the main channel, as the channels between those islands and the east shore are dry at low-tide. Eleven miles above Beacon Island, the river takes a sharp bend to the east and contracts to about a mile across, with a small rocky island in mid-channel, just below it, the north channel is obstructed by a ledge of rock projecting some distance from shore and causing heavy rapids and whirlpools. The eastern bend is two miles long, and above it the river again flows from the south for ten miles from Post Cove, above which its course is from the south-west. Above the narrows the width varies from one mile to two miles, with a long shallow cove on the east side four miles below Post Cove. There is a large rocky island opposite the post, with only a narrow channel separating it from the west shore. George River. Mouth of river.

The *Erik* anchors between the island and the northern point of the cove, lying about half a mile from shore, or within one hundred yards of the muddy flats extending from the point. All the goods are landed with boats at the post more than a mile away, and as this can only be done when the tide is more than half in, the ship always tries to be at George River near the time of highest tides. There is a great difference in the appearance of the river at high and low tide. When the tide is high the water reaches to the foot of the bold rocky shores Difficulty of landing goods at post.

generally without a beach, while at low-tide a wide margin of boulder-strewn mud intervenes between the channel and the rocky banks. Below the narrows are a number of shoals bare at low-tide, especially along the east side. The hills about the mouth of the river range in altitude from 100 feet to 400 feet. As the river is ascended there is a gradual increase in the general elevation, so that above the narrows the hills are from 500 to 1,000 feet high, and the general level of the country is close on 500 feet. Drift lies in considerable thickness in the valleys between the ranges of hills, and along the river, terraces are seen up to 300 feet above the present water-level. Small spruce trees are first seen a short distance above the eastern bend, and the forest becomes quite thick and continuous in the river valley about ten miles above the post.

Surrounding country.

The influence of the tide extends to a rapid some ten miles beyond the post, and above it the river varies from a quarter of a mile to a mile in width and is very swift, flowing in a shallow channel with nearly continuous rapids but no actual falls. It is navigable with boats for about forty miles above the post.

Return to Fort Chimo.

On the 1st of September we left the post and reached Beacon Island on the falling tide, where we remained until next morning, when we laid a course for Saiglorsoak Island, and anchored, in a calm, about nine miles off the south point at the mouth of the Koksoak River. Owing to calm weather we did not reach Fort Chimo until the afternoon of the 4th. The next few days were occupied in stripping the yacht and loading it aboard the *Erik* which left for George River on September 8th. From the 8th until the 17th we remained at Fort Chimo, anxiously awaiting the arrival of the *Diana*, which on the latter date steamed up the river in a heavy snow-storm. Fort Chimo was finally left on the 19th and after a quick passage we were safely landed at St. John's, Newfoundland, on the 25th. From St. John's, passage was taken in the *Ceylon* a tramp steamer partly loaded with iron ore, and after a very rough voyage we reached Halifax on the 30th, where the members of the party separated and I returned to Ottawa on the 2nd of October.

Return to Ottawa.

GEOLOGY.

General Observations.

General geological observations.

The rocks along the south coast of Hudson Strait and the west and south shores of Ungava Bay, present many interesting and complex problems. The occurrence of numerous quartz veins in the bedded rocks near to their contact with intrusive masses of greenstone and

granite are important, as such conditions are favourable to the presence of the more valuable minerals, and although no such minreals were found during the exploration, there is no reason why they should not be found with more detailed search, as many of the veins carry large quantities of pyrites. Bedded iron-ores were found, and although those examined were not of a very high grade, better bodies of ore might doubtless be found in the extensive areas of this iron-bearing series of rocks seen at a number of localities on the coast.

Mineralized quartz veins.

Bedded iron ores.

The long line of coast explored in the limited time at the disposal of the expedition, together with the difficulties of navigation in the shallow waters along the greater part of the coast, where the difference between high and low tide varied from twenty-five to forty feet, only allowed of a hurried examination each day of a few points on the shore, at considerable intervals, so that a thorough examination of the rocks was impossible, and consequently only such relations as could be made out from these isolated observations are here given. These northern coasts are ideal places for geological investigation, owing to the absence of trees and often of all vegetation, which leaves the rocks almost continuously bare; while below the 300-foot level the shores, as they have risen from the post-glacial subsidence, have been smoothed and polished by the pounding of floating ice, which has removed nearly all the drift from the points, leaving the solid fresh rock always exposed.

Difficulties of detailed investigations,

The rocks met with are all of great antiquity, and all are more or less altered by pressure, induced by intrusions of igneous masses which has folded the bedded series and have produced foliation in much of the otherwise massive granites, gabbros, diabases and other greenstones. The foliation of the granites shows that the pressure was exerted from a direction varying from west to south-west. Where massive beds of cherts and quartzite have resisted the folding action, they, with their associated beds of softer shales or slates, have been shoved into ridges by over-thrust faults, giving the hills cliff-faces inland, while their seaward slopes conform closely with the dip of the beds.

Ancient rocks.

Biotite-granite or granitite and biotite-gneiss, especially the latter, together occupy fully three-quarters of the coastal area. The granite and gneiss have commonly a medium texture, and vary in colour from light-pink to flesh-red, the light coloured varieties predominating. These rocks are usually very quartzose and often grade into impure quartzites, and in the gnessic rocks dark-red garnets are usually present. Masses of hornblende-biotite-granite are associated with the biotite-granite and in places appear to represent only more basic portions of

Predominance of granite and gneiss.

the same magma. The gneisses seem to be metamorphic products of several rocks of different age and origin. Some of them are very ancient and probably represent part of the original Archæan complex. Others may represent granites of a somewhat later date, injected into the first, but still long anterior to the time of deposition of those sedimentary beds of Labrador that have been provisionally classed as Cambrian. A considerable part of the gneisses has, however, been formed from the alteration and quartzose infiltration of the bedded series of the Cambrian near the contacts of these rocks with great intrusions of later granites; and, finally, some of the gneisses are foliated parts of these later granitic intrusions. All these gneisses of different origin are very similar in appearance and composition, and often could not be distinguished from one another in the hurried examination given them, except in a few places where the contacts were clearly seen. These places are mentioned later in the detailed account of the exposures examined. Owing to the difficulty or impossibility of differentiating these gneisses of several ages and origins, they have all been classed together and no attempt is made to separate the so-called Cambrian bedded rocks from an older basement complex, except to state that in a number of places the bedded rocks appeared to rest unconformably upon rounded bosses of gneiss, which may represent an older series partly composed of clastic rocks, or may be masses of granite intruded below the newer bedded series, as, owing to the highly metamorphic condition of the newer rocks and their frequent intrusion by later granites it is exceedingly difficult to tell when a contact other than an intrusive one was found.

Probable different origins of gneiss.

The bedded series occurs at intervals along the coast from Fisher Bay to the mouth of George River; its degree of alteration depending largely on its proximity to masses of newer granite and gneisses, which near the contact have broken, squeezed and metamorphosed the beds into highly crystalline schist, and gneisses.

Alteration of bedded series due to granite intrusions.

There appears to have been an orogenic movement subsequent to the granitic intrusions, which has further altered the bedded series, throwing the beds into folds, or into repetitions of the series by a number of over-thrust faults. The rocks when least altered bear a close resemblance to portions of the unaltered series of bedded rocks classed as Cambrian and found in the interior of Labrador along the Hamilton and Koksoak rivers and also on the east coast of Hudson Bay.* They consist largely of black bituminous or graphitic shales, generally bearing considerable pyrite; gray micaceous slates, dark

Resemblance to rocks of the interior.

* Annual Report, Geol. Surv. Can., vol. VIII. (N.S.), pp. 261-282 L.

hornblendic slate, impure dark ferruginous chert, and dark siliceous ferruginous dolomite, the two last often carrying large masses of magnetic iron-ore. The great thickness of light-coloured, siliceous, dolomite found elsewhere with the series, was not seen along the coast. The rocks bear a close resemblance to that part of the Cambrian series found along the lower reaches of the Kaniapiskau and Larch branches of the Koksoak; and the presence of great sills or laccolites of gabbro, together with a peculiar light-green diabase and other greenstones, is a further point of resemblance to the rocks of the Koksoak. Sills of gabbro.

The intrusion of the granite appears to have greatly affected these clastic rocks, changing them into gneisses and schists, so that, for a considerable distance from the contact they resemble lithologically, the Grenville series of the Laurentian. The granites appear not only to have produced the schistosity, but to have caused infiltrations of heated waters carrying silica and silicates in solution depositing large quantities of quartz and felspar between the laminæ of the mica and hornblende-schists, changing these into typical gneisses, which, as well as the schists, usually carry large quantities of garnet often in very large crystals. When associated with gabbros, diabases and their decomposition-products, the bedded rocks are often ramified with quartz veins, generally holding considerable pyrite, these veins are most abundant near contacts with newer granites. Several samples from such veins have been assayed for gold with negative results, but as already explained these cannot be accepted as in any sense conclusive. Infiltrations of quartz. Negative assays.

Details of Rock Exposures Examined along the South Coast of Hudson Strait.

Douglas Harbour.

At the head of the South-west Arm, biotite-gneiss alone occurs in the hills forming the walls of the valley. The direction of the foliation varies from S. to S. 70° W. Similar biotite-gneisses were met with on both sides of the arm to within a mile of its mouth, where, on the north side, the rocks are coarse to fine, pink and red, very felspathic mica-gneiss. The fine-grained variety is usually pink in colour, the coarse-grained has in places an augen-gneiss structure and is red in colour. These gneisses are in contact with a mass of basic rock, about 200 feet thick, composed chiefly of very coarse-textured amphibolite, bearing considerable quantities of dark-red garnet and some light-green decomposed plagioclase. The dark mass has South-west arm.

the appearance of an ancient dyke injected into the gneiss before the foliation and tilting occurred, and was probably altered to its present condition by the same agencies that caused the foliation of the surrounding gneisses. The amphibolite is cut by veins of very quartzose pegmatite, resembling a graphic granite, composed of light-pink felspar, bluish quartz and scales of silvery biotite. In one of these veins near the contact of the gneiss and amphibolite, the lining of the vein next to the hornblende rock was made up of small crystals of dog-tooth spar and rusty-weathering rhombic dolomite, probably derived from the decomposition of the bisilicates of the amphibolite.

Amphibolite.

On the summit of the hill on the north side of the entrance to the South-west Arm, there are several large dyke-like masses of rock which vary in texture from very coarse massive amphibolite to fine-grained, well foliated hornblende-schist. These rocks seem to have been dykes cutting garnet-bearing biotite-gneiss; pressure on the thinner portions of the dykes having changed them into the foliated hornblende-schist. The massive rock is largely composed of coarsely crystalline black hornblende with many crystals of reddish-brown sphene and small spots of greenish-white plagioclase. A finer grained variety is almost wholly composed of black hornblende with little biotite, sphene and plagioclase. The foliated rock is chiefly composed of needle-like crystals of hornblende along with thin plates of greenish plagioclase and occasionally small red garnets. The adjacent biotite-gneiss is largely discoloured by iron rust from the decomposition of the dyke rock.

Garnet-bearing gneiss.

At the end of the point between the arms, pink and light-gray, fine- to medium-grained biotite-gneiss was seen, holding in many bands small red garnets, and including broken bands of blackish hornblende-mica-schist, evidently formed from ancient squeezed dykes greatly fractured; dip of gneiss S. 85° W. $<70°$.

On the western island at the mouth of the harbour, the rock is chiefly medium-textured, hornblende-mica-gneiss, very quartzose and weathering rusty. It is associated with finer grained, garnet-bearing, pink mica-gneiss, which appears to have been cut by the other. Both are cut by a dark basic dyke, one hundred feet wide, running N. 25° W. and seen cutting similar gneisses on the west shore of the bay. The dyke is very fine-grained near its contact with the gneiss and has only a medium texture in the middle. It is largely composed of hornblende with some sphene, many small garnets and some decomposed plagioclase. A number of very large dykes were seen cutting the gneisses in the hills along the coast between Douglas Harbour and Fisher Bay, but no stop was made to examine them.

The islands inside Prince of Wales Island are formed of rusty-weathering, greenish hornblende-mica-gneiss, very quartzose and holding broken bands of hornblende-mica-schist, all being cut by many dykes of pegmatite. Prince of Wales Island

Fisher Bay.

The rocks forming the high islands at the harbour near the head of the east arm of Fisher Bay, are medium- to coarse-textured, pink and yellowish mica-gneisses and mica-hornblende-gneiss usually very quartzose and holding shattered bands of dark hornblende-mica-schist. The pink hornblende-mica-gneiss is evidently an intrusion cutting the yellowish biotite-gneiss and dark bands of schist. All these rocks are cut by numerous dykes of red pegmatite. The general strike of the foliation is N. 30° E.

The point between the east and west arms shows a section, a quarter of a mile long, of dark schists and fine-grained biotite-gneisses. Mica-schist predominates and is usually dark in colour, the lighter coloured variety shading into a mica-gneiss with frequent partings of quartz. Hornblende-schists are interfoliated with the mica-gneiss and schist, and all the schists are very garnetiferous, with crystals varying from a quarter of an inch to one inch in diameter. Strike S. 80° E. A large vein of white pegmatite cuts across the bedding of the schists, and there are numerous veins of quartz, generally parallel to the foliation, the quartz being also garnet bearing. These rocks are probably altered clastics and associated dyke rocks, the clastics being represented by the mica-schists and gneisses and perhaps in part by the hornblende-schists, although most of the latter appear to have been dykes. The hornblende-mica-gneiss, previously described on the islands, appears to have been the cause of the metamorphism of the schists, and these appear to have been a patch of ancient sedimentary crust caught up by a granitic intrusion which occupies both shores of Fisher Bay. Bedded series

The rocks along the coast between Fisher Bay and Wakeham Bay appeared from a distance to be largely granite-gneisses cut by large dykes, but no close examination was made of them.

Wakeham Bay.

The rocks forming the shores of Wakeham Bay seem to be largely foliated granite, and it is impossible to state with the data to hand whether or not all the granite is newer than the series of metamorphic clastics found there. From the hurried examinations made about the Different age of granites.

bay, it seems probable that there are two foliated granites of different age both alike to the eye. One of these cuts and alters the bedded rocks and their associated irruptives, while the other is cut by the irruptives associated with the clastic rocks.

Metamorphic schists.

At the head of the bay, the rocks on the east side are well banded, dark-coloured mica-schists and hornblende-schists often full of garnets. The mica-schists are often rusty, owing to the decomposition of contained pyrite. Associated with the schists are beds of yellowish-white quartzite, from one to four feet thick, containing silvery mica in small scales along partings of the bedding. To the east of a small gully and about four hundred yards from the exposure of schists, the shore rises in abrupt cliffs of more or less squeezed and foliated decomposed diabase, much of which still shows the original diabase structure. These rocks extend for half a mile up the small river flowing into the head of the bay. No beds of mica-schist or other altered clastics were found associated with them. Hornblende-schist is most abundant and shades into a diorite-gneiss, and from that into a massive hornblende-rock with a diabase structure, there being little or none of the original augite remaining in the rock. Numerous small veins of quartz cut these rocks, and in a number of places small cavities and cracks were found filled with calcite probably from the decomposition of the bisilicates.

Granite.

The dark-coloured irruptives occupy the east shores of the upper part of Wakeham Bay for nearly ten miles, to the end of the narrow portion, except at one point about two miles below the head of the bay, where a mass of granite is protruded from the west shore and evidently cuts into the basic rocks. The west shore is all granite, from the schists at the head of the bay to the wide valley five miles below the narrows, beyond which the darker schistose rocks appear to be folded up with granite to the mouth of the bay. The irruptive granite is represented by coarse pink and gray biotite-gneiss, often of the character of an augen-gneiss and sometimes inclosing bands of mica-schist and mica-hornblende-schist, while hornblende is at times a constituent of the gneiss. At the small island near the mouth of the narrows, these gneisses were found associated with a finer grained mica-gneiss free from garnet and seemingly different from the garnet-bearing schists and gneisses.

On the peninsula on the east side of the mouth of Wakeham Bay, the rock is largely a medium-grained, gray mica-hornblende-gneiss with coarser red and dark schistose bands, in which mica and hornblende predominate. These rocks are generally very schistose. There is a

very prominent line of fault that crosses the peninsula diagonally and is continued in the cliff beyond the harbour to the eastward. The fault is marked by a trench, from ten to fifty feet wide and from five to twenty feet deep, filled with angular fragments of rock which near the fault has been greatly shattered with a development of chlorite and serpentine filling small cracks. Prominent fault.

Along the east side of the outer cove between the peninsula and the mainland, pink and red usually coarse-grained granitite-gneiss predominates. It is associated with gray, finer-grained, very quartzose mica-gneiss, usually holding small garnets, and with darker mica-schists. These appear to represent a bedded series and they are cut and twisted by the coarser red granitite-gneisses and also by many large dykes of red pegmatite. The pegmatite is chiefly orthoclase, with a good deal of quartz, and contains occasionally small crystals of biotite, magnetite, garnet and in one place a light-green crystal probably of beryl. Near the head of the cove the granitic rocks are cut by a large dyke of white pegmatite, which runs at a low angle up hill to the southward and directly across the strike of the foliation. The rocks along the shore are much contorted and faulted, the strike frequently changing abruptly. Contorted strata.

On the summit of the hill forming the point at the mouth of the cove, there is a huge dyke, from one hundred to four hundred feet wide, running nearly north-and-south. It cuts light-gray mica-gneiss which has a strike of S. 40° E. Both the gneiss and dyke rock are cut by red pegmatite which often holds fragments of the dyke. The dyke is formed of dark-coloured rock composed chiefly of hornblende, biotite and plagioclase, with many small garnets. The texture varies from medium in the interior to fine-grained and schistose near the edges of the dyke, where the direction of the foliation coincides closely with that of the walls. Great dyke,

Coast between Wakeham Bay and Stupart Bay.

From Wakeham Bay to the vicinity of Cape Prince of Wales, the rocks along the coast are very similar to those last described; the coarse granitites appear to predominate, but as the cape is approached the granitites give place to the bedded series and their associated basic irruptives. A landing was made on a small island about half way to Cape Prince of Wales, where the rocks were found to be chiefly coarse, red granitite-gneiss cutting and inclosing bands of gray, fine-grained, very quartzose, garnet-bearing mica-gneiss; both gneisses being in turn cut by large dykes of red pegmatite.

At Cape Prince of Wales, light-pink garnet-mica-gneiss is associated with bands of hornblende-schist which is also garnet-bearing in places. The schists are cut by small veins of white pegmatite which hardly penetrate the gneiss. The bedding is very regular, with the strike S. 10° W. Near the old station at Stupart Bay, gray and pink mica-gneiss is cut by red pegmatite. Some of the bands of gneiss hold a few small garnets.

Joy and Whitley Bays.

On the end of the long point in Joy Bay, dark-red, coarse-grained augen-gneiss, composed chiefly of biotite and red felspar in imperfect crystals or lumps, is interfoliated with thin bands of red pegmatite holding a little magnetite and brown sphene. Fine-grained pink mica-gneiss, holding a few garnets, occurs in thin bands with the above rocks. About five miles inside the south point of Joy Bay, a dyke from one hundred and fifty to two hundred feet wide runs N. 40° W. up the side of the hill and sharply cuts the gneisses. It ends abruptly at a line of fault on the summit, where the rocks are greatly twisted and the contorted gneisses inclose fragments of the dyke. The dyke is a decomposed diabase, now made up largely of green hornblende, biotite, chlorite and a little plagioclase, and for about three feet from the contact with the gneiss the dyke rock is schistose, the foliation forming a small angle with the walls. The gneiss is a more or less schistose, red and gray mica-gneiss holding considerable silvery biotite. On the summit it is much contorted and mixed with pegmatite and coarser light-gray, mica-gneiss, while at the foot of the hill the strike is regular and the fine-grained gneisses are interbanded with very quartzose layers and hornblende-mica-schists ; strike N. 85° E.

Faulted dyke.

Near the end of the point there is a prominent knob of rock that rises abruptly about one hundred feet above the surrounding hills. It is of a dark basic material consisting chiefly of dark-green hornblende, biotite and plagioclase, with a number of quartzose bands that contain a considerable quantity of magnetite in grains and patches forming a magnetite-gneiss very similar to that found on the Stillwater and Manicougan rivers in Labrador. The whole is cut by small veins of bluish opalescent quartz. A number of similar knobs were seen stretching to the westward along the strike of the gneisses, and the iron-bearing beds and their associated altered basic rocks probably continue for a considerable distance. On the point there is a large quantity of fine-grained diorite, together with quartz-mica-diorite and pink granitite-gneiss ; the last-mentioned cuts and incloses masses of the

Iron-bearing diorite.

more basic rocks. The diorites often contain large masses of coarsely crystalline green hornblende associated with garnet and also small segregations of yellow-weathering dolomite and dog-tooth spar. The iron ores were not noticed in these masses. The foliation of the diorite-gneiss coincides with that of the granitite-gneiss, and the granitite-gneiss appears to penetrate the more basic masses of diorite.

On the end of a small point four miles up Whitley Bay, well banded schists are seen, with light and dark mica-schists predominating. Some of the bands are charged with pyrite and in consequence weather rusty. The mica-schists are associated with bands of hornblende-schist and sericite-schist. All the bands contain garnets, most plentifully in the dark hornblende-schist and mica-schist, where the crystals are often very large, varying from one to two inches in diameter. Numerous quartz veins penetrate the schists, but generally run parallel to the foliation. The quartz is usually smoky and holds much garnet and yellow-weathering dolomite together with plates of light-green sericite and some pyrite.

Pyrites.

Large garnets.

On the low island lying off the point that divides the head of Whitley Bay into two arms, similar garnet-bearing dark mica-schists and hornblende-schists occur, with a very regular dip of N. 45° W. $<10°$ to 20°. In the northern arm of Whitley Bay, the dark, garnet-bearing schists appear to rest upon domes of medium-grained, pink granite-gneiss. In the south arm the rocks are all pink and gray granitite-gneiss and the coast appears to be largely composed of similar gneisses for the next six miles to the west point of Bourgoyne Bay, where schists are again seen intensely crumpled and folded. In this exposure black mica-schist with large garnets is most abundant, then follows a black carbonaceous schist full of small plates of graphite and containing small rhombs of dark-brown ankerite and a good deal of silica, the rock passing with excess of silica into a very fine-grained carbonaceous chert holding ankerite. The other schists are, gray siliceous mica-schist passing into a dark-gray quartzite, rusty-weathering mica-schist containing pyrite in minute grains, and dark-green chlorite-schists and hornblende-schists. A short distance up the bay from the point, the schists are less disturbed and appear to rest upon domes of light-gray granitite-gneiss. On the point in the middle of the bay, only the light-gray, medium to coarse granitite-gneiss is seen, with a strike of N. 35° E., but along the east side of the bay the schists again cap domes of gneiss, and within a quarter of a mile of the point a great fault drops the gneisses below the water-line leaving only schists on the point, where dark-gray, pearly mica-schist, greatly crumpled and faulted, holds much disseminated pyrites.

Contact between schists and granite.

Coast between Whitley Bay and Cape Hopes Advance.

For more than sixty miles to the eastward of Whitley Bay, or to the east side of Diana Bay, the rocks along the coast are chiefly granitite-gneiss which varies in texture from fine-grained schistose to coarse-grained massive, and often appears as augen-gneiss, with the strike of the foliation nearly parallel to the general trend of the coast, or east-and-west, and the dip toward the sea. Many large dykes of diabase and gabbro, more or less decomposed, cut these rocks and appear to have been greatly squeezed since their injection, as they change to chloritic and hornblendic schists wherever the dykes thin out. In many places the gneisses are very quartzose and in a number of the bold headlands the rocks are broken into huge rectangular fragments resembling blocks of thick-bedded sandstone.

Rocks largely granites.

On the islands and along the east shore of Diana Bay, the dark mica-schists and mica-hornblende-schists are again found associated with the granitite-gneiss, which cuts and incloses masses of the schists; these latter predominate along the east shore of the bay and largely occupy the low land forming the wide point between Diana Bay and Ungava Bay. At Cape Hopes Advance and on the islands in the vicinity, coarse, red mica-augen-gneisses and mica-hornblende-gneisses are associated with bands and masses of finer grained similar rocks. All of these cut gray and pink, schistose mica-gneiss, in one place changing the strike from S. 80° W. to N. 40° W., and they also send off red pegmatite dykes, generally along the lines of foliation, into the schistose gneisses.

Dark schists.

Cape Hopes Advance to Payne River.

Ten miles south of the Cape, on one of the Eider Islands, the masses of intruded, red hornblende-mica-gneiss were carefully traced, and were found generally to conform with the foliation of the light-coloured granitite-gneisses; but when followed along the contact, the red gneiss was found crossing the foliation in places and turning the laminæ of the light-coloured gneiss close to the contact, as if by the flow of the intrusion. In many places there is a gradual passage from one variety of gneiss to the other. The irrupted masses when followed along the foliation were seen to pinch out at both ends and have evidently been intruded from below. In texture, the hornblende-mica-gneiss varies from fine-grained to a coarse pegmatitic rock, distinct from later pegmatites which cut all the rocks and hold crystals of tourmaline, biotite and hornblende. Most of the light-coloured granitite-gneisses are very quartzose and are interbanded with darker, more basic gneiss, made up

Relations between intruded granite and gneisses.

A. P. Low.—Photo. 1897.

MOUTH OF WAKEHAM BAY, FILLED WITH ICE

largely of chlorite and decomposed hornblende with greenish plagioclase and bluish opalescent quartz, very similar to that found in the squeezed diabase previously mentioned. This rock is taken to be such an altered diabase, rendered acidic by the accretion of quartz between the laminæ of the bisilicates.

Ten miles south of this exposure, the rocks are dark-gray, mica-schist and hornblende-schist associated with coarser light-gray granitite-gneiss and coarse red granite. Dip. N. 10° E. < 70°. Five miles further south, the intrusive granite predominates and incloses broken bands of finer-grained garnet-gneiss. The next examination was made twenty miles further on, at the north side of Dry Bay where there is a prominent hill composed largely of light-gray granitoid-gneiss with interbanded medium- to coarse-grained, red granitite-gneiss and also bands of mica-schist and mica-hornblende-schist, usually thin and broken. At the south point of Dry Bay the rock is all gray and pink gneiss, varying from medium- to coarse-grained and at times having an augen structure. Strike N. 25° W. From there to the entrance of Payne River Bay, the same gneisses prevail, with an occasional large dyke, altered to hornblende-schist, and at times considerable areas of the mica-schists and mica-hornblende-schists.

Intrusive granite.

At the north point of Payne River Bay, the rock is a coarse, red granitite-gneiss with little foliation. This rock continues about five miles up the bay, when a change is made to a metamorphosed series of clastic rocks which forms the hills and islands of the upper part of the bay and lower portion of the river. The following section was measured across the hills forming the outer point of the bay, on the north side of the river, five miles from its mouth; starting from gray granitoid-gneiss cut by pegmatite and pink granitite, the sequence is as follows, in descending order :—

Section of rocks on north side of Payne Bay.

	Feet.
Light-grayish mica-schist often very quartzose passing into dark-gray quartzite with partings of mica.....	500
Light, yellow-weathering, blotched with brown, fine granular quartzite, with patches of ankerite and some lime. This rock towards the top shades to a dark, bluish-gray, from the presence of large quantities of magnetite in small grains, mixed with quartz, and at times occurring in larger crystalline masses	70
Dark-bluish, slaty quartzite, holding considerable magnetite, and shading upwards into barren, dark quartzite containing a small percentage of lime and lumps and veins of dark chert..........................	350
Dark-gray arenaceous slate.........................	35
Dark, massive, quartzite with a few partings of slate..	40

	Feet.
Dark mica-schist	20
Light mica-schist	10
Dark mica-hornblende-schist holding garnets and probably a squeezed dyke	8
Light-gray, schistose, biotite-gneiss	500

General dip of beds S. 80° E. < 30° to 60°.

The small islands in the north bay are formed of dark-gray, siliceous mica-schist, that weathers rusty from the decomposition of disseminated pyrite. At the mouth of the small river flowing into the bay, there is exposed, in the hillside to the east of the river, one hundred feet of light-blue, finely crystalline, siliceous limestone, greatly shattered and recemented by networks of small quartz veins, so that the rock closely resembles the siliceous limestones of other Cambrian areas of Labrador. The limestone is overlain by about a thousand feet of silicious, calcareous rock containing large patches of brown ferruginous dolomite interlaminated with black chert and also containing masses and veins of that mineral. The rock decays unevenly, leaving cavities where the carbonates have weathered away. Interbedded with these cherty rocks are bands containing much actinolite in large crystals radiating through a siliceous rock. The actinolite is light-coloured in the rock-mass, but there are veins containing dark steel-gray hornblende in masses of radiating crystals and others containing quartz and dolomite with sericite along the walls. The overlying rock is a rusty-weathering mica-schist similar to that met with on the islands of the bay, and it probably occupies the interval of swampy land between this hill and the range where the previous section was obtained. The islands at the mouth of Payne River belong to the same series, which is readily identified by the yellow-weathering dolomitic beds.

Hornblendic cherts.

These rocks occupy both sides of the river for about ten miles above its mouth, when they give place to granitite-gneiss. Along the river the clastic series is largely displaced by sheets of diabase, gabbro and hornblendic, chloritic and sericitic schists, which appear to have burst up between the bedding planes of the clastics like the great interflows of diabase and gabbro near the forks of the Kaniapiskau and Larch branches of the Koksoak River,* the only difference being that the pressure and metamorphism appear to have been greater about Payne River.

Sheets of decomposed gabbro.

The rocks of the upper part of the river are mostly pink and gray biotite-gneiss cut by many large dykes of diabase which are seen in the bare walls on both sides of the valley.

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* Annual Report, Geol. Surv. Can., vol. IX. (N.S.), p. 33-34 L

Payne River to Gyrfalcon Islands.

To the southward of the mouth of the river the coast is chiefly occupied by light-coloured gneisses. At a stopping place fifteen miles from the river, there is an immense mass of amphibolite, at times containing violet plagioclase and cut by large veins of violet pegmatite. Owing to shallow water, no landing was made for thirty miles from here, to the large islands in the mouth of Hopes Advance Bay, where light- and dark-gray, very quartzose mica-gneisses are interbanded with garnet-bearing hornblende-schist. Dip N. 50 E. < 20° to 45°. These are cut by huge dykes of red pegmatite, and on the west side are cut off by a mass of coarse, dark, decomposed gabbro or diorite. Amphibolite mass.

On Cone Island of the Gyrfalcon group, the rocks are somewhat contorted and dip eastward; they consist chiefly of impure quartzite holding in places a good deal of garnet and small scales of biotite, and shade into a quartzose biotite-gneiss. Dark mica-diorite-gneiss, sometimes holding garnets, occurs with them, apparently interbedded. The Gyrfalcon Islands are arranged in a series of chains running north-west and south-east parallel to the strike of the rocks, and appear to have been formed by a series of thrust-faults, which have pushed the rocks into sharp ridges with perpendicular faces towards the south-east and gentler slopes in the opposite direction corresponding to the dip of the bedding of the rocks. Quartzites and very quartzose mica-gneisses predominate and are associated with a highly felspathic mica-diorite-gneiss which often resembles a decomposed crushed anorthosite. All the rocks contain more or less garnet. A few bands of rusty-weathering quartzite hold patches of ankerite and probably represent a more highly metamorphic phase of the rock met with at the mouth of Payne River. Crushed anorthosite.

Gyrfalcon Island to Koksoak River.

The rocks forming a small island on the south side of Leaf Bay, are chiefly dark-green amphibolite and hornblende-schist, together with bands of quartzose, schistose mica-gneiss cut by large dykes of light-pink pegmatite and coarse red granitoid-gneiss. The amphibolite is very coarse in texture near its contact with the pegmatite and granite. From this island to Stony Point, the shore is largely formed of light-coloured granite and gneiss. On the small islands off the point, a medium-grained, light-pink granitoid-gneiss predominates, and holds broken bands of light-gray biotite-gneiss often containing small garnets; both the granitite and the gneiss are cut by red pegmatite. The coast from Stony Point to the mouth of the Koksoak is low, with few rock-exposures, all of which appear to be similar to that last described. Amphibolite.

The rocks along the Koksoak to Fort Chimo have been described in a previous Report.* They consist of a bedded series of mica-schists hornblende-schists and gneisses cut by hornblende-granite and large veins of pegmatite, the irruptives predominating towards the mouth of the river.

Koksoak River to George River.

Gneisses and granites.

The coast between the Koksoak and Whale River is very low, with shallow water extending far out and quite unapproachable with the yacht until the channel on the west side of Big Island is reached, where the shores become higher and give an almost continuous rock exposure up Whale River to the Hudson's Bay post.

The rocks are all light-coloured gneisses and granites, being made up largely of irruptives containing shattered bands of a highly metamorphosed bedded series, now forming very quartzose, garnet-bearing biotite-gneiss and schist, with less hornblende-schist than to the northward. Between the mouths of Whale and George rivers, the wide flats and boulder-ridges which extend far out from the low shores rendered close examination of the rocks impossible, and only a few landings were made on islands and rocky points. Wherever an examination was made, however, gray biotite-gneiss with mica-schist and hornblende-schist were found, cut and shattered by red granites and pegmatite.

The same rocks occur on the islands along the east side of the mouth of George River and up that stream to the Hudson's Bay post. At Gull Island and along the west shore for ten miles above it, there are large exposures of dark basic rock, now chiefly diorite-gneiss, and evidently representing large masses of gabbro or diabase corresponding to the basic irruptives met with in the bedded series as previously described.

Glacial Geology.

Extent of ice sheet.

The entire coast visited has at one time been covered by an ice-sheet sufficiently thick to over-ride the highest hills, and the movement of this ice caused the removal of the loose material leaving only large blocks and boulders strewn over the rocky surface of the rounded hills, which is everywhere grooved and striated by ice action. Little or no fine drift remains on any of the hills more than 400 feet high, and in the valleys between the higher hills there is

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* Annual Report, Geol. Surv. Can., vol. VIII. (N.S.) p. 221 L.

usually not much fine material, the débris being mostly boulders and broken rock.

The list of glacial striæ given below, shows that the general motion of the ice was from the interior radially towards the coast, so that, as a rule, the striæ on the hills run nearly at right angles to the general trend of the coast. The direction of the ice-flow was, however, modified by that of deep valleys along the coast, the ice-stream accommodating itself to the valleys and pouring down these into the sea. The striæ are not well marked on the exposed points and islands along the coast below the 400-foot level, having been obliterated by the pounding of floating ice during the uplift subsequent to the main period of glaciation. Radial flow of ice.

List of Glacial Striæ.

List of glacial striæ.

Douglas Harbour, on hills at head of S.W. Arm	N. 75° E.
" " at point between the arms	N.
" " 2 miles from point, W. side S. W. Arm.	N. 25° E.
Fisher Bay, on top of island at anchorage	N. 50° E.
" " on side " "	N. 10° E.
Wakeham Bay, on island at mouth of narrows	N. 80° E.
" " on summit of the peninsula	N. 50° E.
" " on summit of east side at mouth	N. 25° E.
" " " "	N. 30° E.
Cape Prince of Wales, on end of cape	N. 35° E.
Joy Bay, 5 miles from S. point on summit of hill 500 ft. high	N. 85° E.
" on end of south point	N. 80° E.
Whitley Bay, on the long low island in the bay	N. 40° W.
10 miles east of Whitley Bay, on summit	N. 55° E.
25 " " "	N. 25° E.
Diana Bay, south-west point of the large island	N. 40° W.
Cape Hopes Advance	N. 60° E.
Eider Islands.	N. 25° E.
" "	N. 40° E.
" "	N. 40° E.
Flat Bay, summit of hill on north side	N. 40° E.
" south point	N. 75° E.
Plover Islands	N. 65° E.
12 miles north of Payne River Bay	N. 45° E.
On summit of hills at end of exploration, Payne River	N. 40° E.
10 miles south of Payne River Bay	N. 20° E.
Cone Island Gyrfalcon Islands	N. 35° E.
Mainland at Gyrfalcon Islands	N. 30° E.
Leaf River Bay, small island on south side	N. 35° E.
15 miles west of mouth of George River	N. 5° W.
Island on the east side of " "	N.

Marine Terraces.

The greatest depth of submergence and the periods of rest during the uplift of the land toward the close of the glacial period, are marked

Terraces marking limits of subsidence of the land.

by a series of terraces cut into the drift occupying recesses between the rocky hills of the bold coast, or, in the lower country along the west side of Ungava Bay by flat plains that rise in steps from the present sea-level. The terraces were seen wherever sufficient drift material remained to form them, and their heights were estimated by eye, or, where convenient, their altitudes were obtained by means of the aneroid barometer. The highest terraces measured were found at the head of the south-west arm of Douglas Harbour, and near Dyke Head, some thirty miles east of Whitley Bay, or more than one hundred miles east of Douglas Harbour. In both places the barometric height of the highest terrace was 405 feet and the tops were evidently an ancient shore-line under a rocky cliff, the surfaces being made up of moderately large, rounded boulders. This upper terrace is taken to represent the greatest depression of the land in this part of the Labrador Peninsula at this time, and is considerably less than that of the western portion, where the marine terraces are found to an elevation of more than 700 feet above sea-level in the vicinity of Richmond Gulf on Hudson Bay.* The amount of uplift along this part of Hudson Strait appears to have been constant, from the levels of the terraces cited above, and in Ungava Bay it seems to be somewhat less. Unfortunately no definite highest-level terrace was found there south of Payne River, where the highest terrace seen is only 325 feet above the sea. Those about the mouths of the Koksoak and George rivers are not higher. Along the Koksoak River the highest-level terrace is about 300 feet above the river near its mouth, and as the stream is ascended the terrace also rises so that at Stillwater Lake, 175 miles south-west of the mouth of the river and 520 feet above sea-level the upper terrace is 200 feet above the surface of the lake. This highest terrace is a well marked feature of the river-valley and is continuous from the mouth to Stillwater Lake. It is accompanied by marine stratified clays, so that its marine origin is undoubted.

Highest terraces.

Unequal uplift of Northern Labrador.

From the foregoing facts, it would appear that there has been an unequal uplift of the northern portion of Labrador, the maximum, more than 700 feet, having occurred along the coast of Hudson Bay in the vicinity of Richmond Gulf; and that this region of maximum uplift was continued inland, eastward, more than half way across to Ungava Bay; while from Stillwater Lake a gradual decrease occurs to about the southern part of Ungava Bay, where the uplift is only about 300 feet. Passing northward, however, the uplift again becomes greater, so that at the mouth of Payne River it reaches 325 feet and along the southern shore of Hudson Strait 405 feet.

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* Annual Report, Geol. Surv. Can., vol. IX. (N.S.), p. 41 L.

At Douglas Harbour, terraces below the upper level were noted at 275, 212, 91, 46 and 37 feet. On the peninsula at the mouth of Wakeham Bay, well marked terraces occur at 180, 165, 150, and 65 feet, and at the head of the bay there is a broad terrace 90 feet high. About Cape Prince of Wales the lower terraces are persistent, and at the mouth of the river flowing into Joy Bay the drift deposits are terraced to above 300 feet. On the points of Joy and Whitley bays there is a continuous terrace at an elevation of 65 feet. The terraces at Dyke Head, lie in a small valley at the bottom of a cove facing the strait and afforded one of the best examples of terraced beaches seen on the coast, the heights being 405, 330, 275, 255, 220, 175, 90 and 85 feet, any lower terraces being lost by the scouring away of the drift from the rock. Between Cape Hopes Advance and the mouth of Payne River, the country is generally low and drift-covered, and is made up of flat-topped plains that rise in low terraced steps, as only isolated rocky ridges have an elevation above 200 feet, high-level terraces are not frequently seen. At Cape Hopes Advance there is one at 190 feet, and on the side of a rocky hill near the Plover Islands there are two beaches at 200 and 75 feet respectively. At the mouth of Payne River, the drift between the hills shows terraces at 323, 314, 304 and 184 feet besides others at lower levels. Along the river the valleys between the hills are filled with terraced drift up to 325 feet, the lower terraces are cut from stratified clay which rises about 150 feet above the level of the river, and is overlain by stratified sand nearly to the level of the highest terrace.

Douglas Harbour.

Dyke Head.

Payne River.

From Payne River to the mouth of the Koksoak, the low shores and slowly rising country in rear, gave only low terraces, seldom exceeding an elevation of 100 feet. The coast between the mouths of the Koksoak and George rivers is also low, and terraces are only seen along the flanks of the hills several miles inland. They appear to be continuous, with the highest estimated to be about 300 feet above the sea. Along the lower reaches of the George River to the Hudson's Bay post, the gullies and banks where drift is lodged are terraced to about 300 feet above the present level of the river, and the stratified clay appears to rise upwards of 100 feet above the water and is capped with stratified sand.

Koksoak and George rivers.

R. Bell, Photo., 1897.

NEAR BRUCE HARBOUR, LOOKING NORTH.
Showing band of white crystalline limestone.

GEOLOGICAL SURVEY OF CANADA
G. M. DAWSON, C.M.G., LL.D., F.R.S., Director

REPORT

OF AN EXPLORATION ON

THE NORTHERN SIDE OF HUDSON STRAIT

BY

ROBERT BELL, M.D., LL.D., F.R.S.

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST EXCELLENT MAJESTY
1901

To G. M. DAWSON, C.M.G., LL.D., F.R.S., &c.,

Director Geological Survey of Canada.

SIR,—The accompanying report on my field-work of 1897, on the northern side of Hudson Strait, contains fuller descriptions than the summary report, already published, as to the topography of the region surveyed or explored, together with all the details in regard to its geology, which are considered worth mentioning. Some general information on Baffin Land is also given. The appendix contains lists of the plants and insects obtained during the season. These will serve to supplement the published lists of similar collections which I made in Hudson Strait in 1884 and 1885, when many specimens were also secured in other departments of zoology and lists of the species published in my reports for those years. The illustrations are selected from my photographs as characteristic examples of the scenery of the coast. The topography and geology of the north side of the strait are reduced from my track-surveys, originally plotted on a scale of 4 miles to 1 inch, and which required only slight adjustment to bring them into correspondence with the numerous observed latitudes and longitudes.

I have the honour to be, Sir,

Your obedient servant,

ROBERT BELL.

Ottawa, December, 1900.

NOTE.—*The bearings throughout this report are given with reference to the true meridian.*

REPORT

OF AN EXPLORATION ON

THE NORTHERN SIDE OF HUDSON STRAIT

BY

ROBERT BELL, M.D., LL.D., F.R.S.

My summary report for 1897 contains a general account of my exploration of that year on the northern side of Hudson Strait, or in the southern part of Baffin Land, including a sketch of the geographical and geological results. The present report is intended to give a fuller description of the topography and geology of this comparatively new region, together with many facts which were observed in reference to its physical features, natural history, botany, climate and other matters which may be of interest or value. As stated in the above mentioned report, the opportunity for making this exploration was afforded by the sending out of the sealing steamer *Diana* by the Department of Marine and Fisheries to make investigations in the strait for other purposes.

Objects of this report.

Diana expedition.

I was provided with a small yacht at Halifax, which was carried on the deck of the steamer, and a crew of four sailors was engaged to accompany me to the field of operations, but I had no assistant. The *Diana* left the above port on the 3rd of June, and our course lay through the Strait of Belleisle, which was clear at that season, but owing to ice encountered off Hamilton Inlet, it was the 22nd of June before we entered Hudson Strait, which was found perfectly free of ice. Owing to the ship keeping too near the north shore in going through the strait, we became jammed in ice off Big Island, which stands out prominently like a great pier projected from that side and intercepts the drifting shore-ice. This contretemps delayed us considerably, and it was therefore not till the 12th of July that the *Diana* had completed her first voyage into Hudson Bay.

Enter Hudson Strait.

Enter Hudson Bay.

It was originally intended that I should be landed at a point in the vicinity of Kings Cape, or as near as possible to the junction of the north-east side of Hudson Strait with the east shore of Fox Basin,

but this was found to be impracticable at the time we happened to arrive near that point on account of a rapidly moving ice-floe. Eventually I commenced work at Ashe Inlet in Big Island. Before leaving the *Diana* the plan agreed upon was that I should proceed north-westward up the coast as far as possible, consistent with a tolerable certainty of being able to return to Ashe Inlet in order to meet the ship there on the 10th of September, so as to be taken to St. John's, Newfoundland, as arranged by the Minister of Marine and Fisheries. Had the captain of the *Diana* succeeded in landing me at Kings Cape, I could probably have explored about double the length of coast that was possible under the new arrangement. Owing to the very imperfect knowledge of the coast in the neighbourhood of Kings Cape and beyond it, and the absence of any chart showing the coast even approximately, it was impossible to appoint a place to meet the ship in that vicinity, otherwise I might have kept on till I fell in with her. Being therefore obliged to go twice over the same ground, to say nothing of the delay in getting to Ashe Inlet, I was able to accomplish little more than half of what could otherwise have been done. Still, I managed to complete a good track-survey as far as Chorkbak Inlet, over a length of 250 miles of coast, checked by many observations for latitude and longitude, in addition to a traverse all around Big Island, 30 miles in length and 16 in breadth, surveys of numerous inlets and of a route for 50 miles into the interior, to the shores of Lake Mingo, lying close alongside Lake Amadjuak, which was also seen and bearings taken to various points on its shores. Having completed the above, I returned to Ashe Inlet, which was reached ten days before the date appointed. The interval was filled up by an exploration around North Bay nearly to Icy Cape, which lies east of Big Island. On the return voyage the *Diana* passed close to the north end of Akpatok Island, which had heretofore been supposed to be a separate island to which the name of Green Island had been given. Having rounded the north-east point of this island, we coasted southward along part of its eastern side, stopping for a day at anchor midway down. This afforded me an opportunity of landing to examine the rocks, which were described in my summary report. It is unnecessary to repeat the notice of the remainder of my return journey to St. John's and Ottawa, which is given in the Summary Report for 1897.

Plan of operations.

Length of journey doubled.

Work accomplished.

Akpatok Island.

Dimensions and Area.

Baffin Land one island.

The territory, now known as Baffin Land was, until about 1875, supposed to consist of different islands known as Cockburn Island, Cumberland Island, Baffin's Land, Sussex Island, Fox Land, &c. It

seems to be now established that these are all connected and that there is but one great island, comprising them all, to which the name Baffin Land has been given. It forms the northern side of Hudson Strait, its southern extremity being in latitude 61° 42′, opposite Cape Chidley, and it extends in a north-westerly direction to latitude 74° 00′. It has a length of about 1,005 English statute miles with an average breadth of 305 miles, its greatest width being 500 and its least 150 miles. Its area approximates 300,000 square miles, and it therefore comprises about one tenth of the whole Dominion. It is the third largest island in the world, being exceeded only by Australia and Greenland. Dimensions. Area.

Discoverers.

The land around Frobisher Bay was discovered by Sir Martin Frobisher in 1576. Captain John Davis discovered Cumberland "Island," now known to form the eastern part of Baffin Land, in 1585. The northern part of the great island was discovered by Captain William Baffin, in 1616. It was, until recently, called Cockburn Island, although it had been named Baffin's Island or Baffin's Land by Lieutenant (afterwards Admiral) E. W. Parry, in 1821, 'out of respect to the memory of that able and enterprising navigator.' These lands therefore formed part of the British possessions in North America, by right of discovery, dating from periods of 143 to 183 years before the acquisition of Canada. They were formally transferred to the Dominion by Order-in-Council of the Imperial Government on the 1st September, 1880, together with all the islands of the Arctic archipelago lying to the northward of the mainland of the continent. Discovery. Transferred to Canada.

Narrative and General Description.

For a short narrative of my season's operations and a brief general description of the portions of the coast and interior examined, I cannot do better than quote the following from my summary report, written very soon after my return: Narrative of operations.

The *Diana* brought me to Ashe Inlet on the 19th July, and my yacht was launched there on the 20th. The following day the wind blew too strongly for us to get out of the inlet and the time was spent in fixing its position relatively to other geographical features of Big Island, as a commencement of a track-survey of the coast. On the 22nd we made a start to windward, intending to pass up on the outside of Big Island. Before leaving the inlet, early in the morning, we Land at Ashe Inlet.

Eskimo guide

fortunately found an Eskimo who had some knowledge of the English language and was acquainted with the south coast and the southern interior of Baffin Land, and I engaged him to go with us as guide and interpreter for the whole of our journey. He had slept near our anchorage and had nothing with him but a gun.

Take inside passage.

Reeves Harbour.

The hull of our yacht was made of one inch white-pine boards. She was, therefore incapable of contending with the ice, and our safety lay in avoiding it altogether. We had not gone many miles up the outer coast of Big Island, when we met an ice-pack lying in our course as far ahead as the eye could reach. Our Eskimo guide now advised us to try the passage between the island and the mainland, and accordingly we turned back and attempted to get round the south-eastern extremity, but on account of the wind failing us altogether we were able to make only about six miles to the south-eastward of Ashe Inlet. Here we discovered a much better harbour than Ashe Inlet, and I named it after Reeves, our sailing master. It is about a quarter of a mile in diameter, has two deep narrow entrances, a good bottom for holding and a depth of from five to fourteen fathoms at low water. The next day we rounded the south-eastern extremity of Big Island, which is about thirty miles long, but owing to a strong north-west wind we were obliged to anchor for the night among some small islands lying north-east of this point. It was fortunate that we took this route, as we found the family and relatives of our guide camped on the lower end of the island, and he was now able to make arrangements with them for his absence till September. He had not previously told us anything about his people.

Four harbours discovered.

At this season of the year there was continuous daylight in Hudson Strait during the whole twenty-four hours, and we sailed at two o'clock the following morning (24th) and made a track-survey of the inner side of Big Island as well as of a part of the main shore opposite. Two good harbours were discovered on this side of the island towards the northern end, and two more on the coast of the mainland in this vicinity.

Archipelago 25 miles wide.

In proceeding north-westward up the coast from Big Island the shore began to be fringed with innumerable rocky islands thickly clustered together. The breadth of the belt or archipelago increased as we advanced, until we approached the long inlet or fiord called Chorkbak, where our exploration ended. Here the islands became less numerous. The maximum breadth of the archipelago is about midway between Big Island and this inlet, and is about twenty-five miles. The islands vary in size from ten miles in length down to

mere rocks. The spaces between the large ones are filled up with smaller islands having a great variety of dimensions and form. As a rule, the largest and highest islands lie towards the mainland, while the outermost ones are smaller and lower. In sailing among these islands it was only when near the outer edge that we could see a clear horizon to the southward.

The whole coast is rugged and for the most part mountainous. The innermost islands interlock with the bays and points of the mainland in such a manner that it is impossible to know without the aid of a guide whether one has reached the main shore or not. On ascending the higher hills or mountains of the outer ranges on the mainland, long channels of the sea can be seen running inland in different directions among the hills, which so closely resemble those among the adjacent large mountainous islands that only a person already acquainted with the geography could trace the coast-line of the mainland. The larger islands are equally hilly and rugged and the channels between them are usually not wide. Viewed from the top of a distant hill, so that the intervening channels cannot be seen, the eye fails to detect any difference between the general appearance of the islands and the mainland. The conditions may be best described if we imagine a rough mountainous country, rising as a whole gradually to the northward, to have been half submerged. The outer islands, which are also the smallest and most scattered, represent the more completely sunken hills, while as we proceed inward the progressingly larger and larger ones represent the less and less submerged areas and ranges, until, at last, we find only narrow channels of the sea running into the solid land. Besides these narrow and sometimes tortuous channels, numerous wide and tolerably straight fiords run inland. These generally have high hills on either side of them.

Mountainous coast.

Many channels.

The islands.

On leaving Big Island, it soon became evident that it would be impossible to make an instrumental survey of any considerable part of such a coast as this in the limited time that would be at my disposal, and that this time would be most advantageously spent in making the best track-survey possible under the circumstances, especially as it was neeessary to devote a portion of the time to geological observation. I therefore determined to keep an accurate record of all the courses we followed among the islands or up the fiords, under the guidance of our Eskimo pilot, and also as good an estimate as possible of the length of each course, plotting them on diagrams as we went along. On these diagrams the relative positions of all the surrounding points, bays, islands, hills, &c., were also marked by the aid of many cross-bearings

Character of survey.

Astronomical observations. and estimated distances. Observations for the latitude and the variation of the compass were taken every day, and I also obtained numerous sights for longitude.

Good harbours. The coast abounded in good harbours, and careful sketch-plans with soundings were made of all those that we visited. The heights of numerous hills, which I climbed, were ascertained by barometer. Observations and collections. A sufficient number of photographs for illustration were obtained; notes were recorded on all subjects that might be of interest in regard to this little-known region, whether from personal observations or from information supplied by the natives.

Weather. From the time of our leaving Ashe Inlet, on the 21st of July, until we returned to it again on the 1st of September, the weather was mostly fine and bright, although cold upon the water, but we suffered Calms much delay from calms. The main obstacle to our progress, however, was the field-ice, which appeared to have come into the strait from the eastward during the winter or early spring, and to have insinuated Field-ice. itself into every channel and fiord. When not tightly packed, it was constantly moving hither and thither under the influence of the rapid and changeful currents generated by the high tides of the strait.

Tides of Hudson Strait. The height of the mean tide at Big Island was ascertained by Mr. Ashe to be 30 feet, and the time of high-water at full and new moon to be 9h. 32m. Farther west we could not determine the time of high or low water, which was irregular, on account, apparently, of the effect of the reflux from Hudson Bay upon the in-coming or out-going tide of the strait; while the local conditions, such as the directions, divisions, depths and widths of the channels still further complicated the problem. In trying to navigate our frail yacht in the open spaces, the heavy ice would set down upon us or run together and threaten to crush our little vessel in the most unexpected manner. Our undertaking was, therefore, constantly accompanied by great danger and anxiety, and it was only by constant vigilance night and day that we were fortunate enough to escape any harm during the entire trip.

When we had reached a point a little beyond the entrance of Amadjuak Bay. Amadjuak Bay, we found the ice closely packed among the islands all around us. But the next morning the wind or tide had opened a lane up the fiord itself and I explored it to its extremity. The ice outside still remained packed, and in order to utilize the time most profitably, I determined to make an exploration into the interior of the country. Two seamen were left in charge of the yacht with instructions to make Journey inland. lines of soundings in the fiord, and with the other two and the Eskimo

guide, I started on a journey northward towards Amadjuak Lake, one of the bays of which was supposed to be at no great distance from this part of the coast. It proved, however, to be upwards of fifty miles inland. This journey occupied seven days, and the results will be described further on. When we returned to the head of the fiord, the sea was found to be open and we immediately set sail to continue the westward exploration of the coast.

On the 22nd of August we had reached Chorkbak Inlet, and in case of being detained by calms or head winds on our return journey, I judged it prudent to turn back from this place in order to be sure of being able to keep our appointment to meet the *Diana* at Ashe Inlet on the 10th of September. In returning I followed a course which lay outside of that of the westward journey, so as to make a second line of track-survey among the island belt and of the outside of Big Island. We had fairly good weather and anchored again in Ashe Inlet on the 1st of September. In order to fill up the time with advantage till the 10th, I ran across to the main north shore opposite the island and explored it topographically and geologically nearly to Icy Cape. I then returned to Asle Inlet before the 10th, but owing to stormy weather, the *Diana* was not able to enter until the 12th. It only required two or three hours to transfer our outfit and surplus stores to the steamer and to dismantle the yacht and make her ready to tow across the strait to Fort Chimo, where I proposed to leave her, as it was not considered advisable to risk taking her to St. John's. Newfoundland, on the deck of the *Diana*. On the following morning we reached the northern extremity of Akpatok Island in Ungava Bay, and after coasting along the eastern side of the island we anchored elose to the shore about half-way to the southern extremity. This afforded me an opportunity of landing in order to take photographs, examine the rocks, collect fossils and ascertain the heights of some of the cliffs and hills by the barometer. This was so far as I am aware, the first landing of a white man upon this island. Its position and general form and direction are erroneously represented upon the latest charts. The hypothetical "Green Island" of the charts corresponds with the northern part of Akpatok Island as determined by the observations of Captain Whiteley, and it is probable that this, seen from the northward, was mistaken for a different island.

Turn back from Chorkbak Inlet.

Rejoin the Diana.

Land on Akpatok Island.

General Aspect.

Baffin Land has the usual sub-arctic climate and is destitute of trees. The rocks are principally Laurentian, not only in the portion which

Genera nature of the rocks.

I explored, but also all along the north-eastern coast, judging from the accounts of Dr. Franz Boas, who has travelled over the greater length of this side of the island, as well as from other evidence. The island has a generally mountainous, or hilly and barren aspect, but from the western shore bordering on Fox Basin a considerable area of flat Silurian limestone extends inland to Lake Nettilling and there are also areas of similar rocks in the northern parts of the island. In some districts comparatively level Laurentian areas occur. These level portions are the favourite haunts of the reindeer in summer. At this season the rocky Laurentian hills have generally a dark or nearly black appearance, owing to a growth of lichens upon them, but this sombre character is often relieved in valleys and on hill-sides by strips and patches of green, due to grasses and sedges in the lower parts and to a variety of flowering plants on sheltered slopes exposed to the sun. The landscape is further relieved by long banks and smaller patches of white where the last of the snows of perhaps several winters remain in shaded places.

Aspect.

Flat Silurian limestone.

Green portions.

In two valleys of the interior I found accumulations of ice resembling small glaciers, but which had evidently been formed mainly by the constantly overflowing and simultaneous freezing in the winter of streams that in the summer run under the ice or in canyons they have cut through it.

Ice in valleys.

Mountains and Glaciers.

The mountains of Baffin Land may be grouped as three principal ranges, all running north-north-westerly nearly parallel to the eastern side of the island and the western coast of Greenland, the north-eastern or outmost range being the highest and the south-western the lowest.

Direction of ranges.

According to Dr. Franz Boas, the high interior of Baffin Land, lying just north of Cumberland Sound, is apparently all covered with ice like the interior of Greenland. Around the margins of this ice-cap the general elevation above the sea is about 5,000 feet, and it rises to about 8,000 feet in the central parts. Another area of smaller extent, but apparently equally high, lies a short distance to the north-west of the one just described. The high land, mostly ice-covered, lying north-east of Cumberland Sound and stretching over to Exeter Sound, is probably at least 5,000 feet high. Large portions of the northern interior are over 1,000 feet above the sea, often nearer 2,000 feet, while the higher parts of these areas may be 3,000 feet or more. The mountainous region between Frobisher Bay and Cumberland Sound appears to have an elevation of between 2,000 and 3,000 feet. The

Elevations of the high lands.

southern extremity of the island, between Hudson Strait and Frobisher Bay, is covered by the Grinnell glacier, between 70 and 100 miles in length from south-east to north-west, between latitude 62° and 63°, with a breadth of about 20 miles. The smooth summit of the glacier is distinctly visible from vessels in Hudson Strait in certain conditions of the weather. I have been told that one narrow stream of ice from its southern side reaches the water of the strait, but I was unable to verify this. The rough existing charts represent the northern side of the glacier as sending ice down at two or three places into the heads of inlets of Frobisher Bay. The Eskimos call the Grinnell glacier Ow-u-i-to, and my guide, Twimi, knew of only one point at which it discharged into the sea. This place is called Pak-a-lui-a, and is not far to the north-west of Resolution Island. This man stated that all the icebergs which enter and pass up the strait, and which are well known to be of small size, come from Pak-a-lui-a. He also informed me that in the same neighbourhood, or at the second principal point north-west of Gabriel Strait, codfish are very abundant and many of them of large size. During my visit to these regions in 1884 and 1885 vague reports reached me of the existence of glaciers on some parts of the shores of Fox Basin, but as no icebergs have been seen in the basin nor any known to come out of it, should there be any land ice in that direction it does not appear to reach the sea. No glaciers, even of small size, are known to occur in Labrador, and there are probably none in southern Baffin Land or elsewhere to the west of the Grinnell glacier.

Grinnell glacier.

Codfish abundant.

In the southern part of the great island, or along the north-east side of Hudson Strait, the land is high all the way from Resolution Island to Fair Ness, the mountains near the coast rising from one to two thousand feet above the sea, but some of those which I saw in the interior at a distance of about one hundred miles north-eastward of Fair Ness, appeared to be much higher and were capped with snow. The prominent point just named marks the termination of the outer high range on the north side of the strait and behind it is Markham Bay, with a breadth of fifteen miles. On the north side of this bay the land becomes much lower and, except in a few places, it continues so to beyond Chorkbak Inlet, but as we approach the vicinity of Kings Cape, or Sik-o-su-liat, the height again becomes a thousand feet or more. The Eskimos informed me that the high and rugged land, (Laurentian) of this promontory, continued northward up the east side of Fox Basin to the Koukdjuax River, which flows out of Lake Net-tilling. Beyond this the shore of Fox Basin becomes low and flat for a considerable distance. This condition, as elsewhere explained, is

Character of coast.

believed to be due to the presence of beds of Silurian limestones lying almost horizontally.

Lakes.

Two great lakes.

Judging from what I saw of the interior of Baffin Land on my journey to Lake Amadjuak and on my return by a somewhat different route, the mountains are everywhere interspersed with lakes. Two of them are known to be of great size. Lake Nettilling is propably about 140 English statute miles in length, by 60 in breadth. Lake Amadjuak may exceed 120 miles in length by 40 in breadth in its central part, so that their united area must be very considerable. The greater diameter of each of these lakes lies north-west and south-east, or parallel to the mountain ranges. Lake Mingo, whose outlines and dimensions were sketched by the aid of numerous bearings and estimated distances, has a somewhat rounded or compact form and is at least 15 miles in diameter. It lies close to the south-western side of Lake Amadjuak and discharges into it by a very short river, which the Eskimos informed me has only a moderate current, adding that they paddle through it either up or down stream in their kyaks. I would therefore assume that the difference of level between these lakes does not exceed ten feet. Lake Mingo was found by barometer to be just 300 feet above the level of the sea, so that the elevation of Lake Amadjuak will be about 290 feet. The natives, including my guide, who have seen the Koukdjuax River, which discharges this lake into Fox Basin, with a course of some fifty or sixty miles from its western bay, describe it as a very large stream with numerous rapids. This is only what might be expected, since the rate of descent is probably five or six feet per mile. Various reports reached me of a large lake lying not far from the head of Frobisher Bay, but these may refer to Lake Amadjuak, which extends in that direction. The lakes, of which sketches were made on my journey from Amadjuak Bay to Lake Mingo, are shown on the accompanying map, and they will be referred to further on in describing the geology of the routes followed in going and returning.

Lake Mingo.

Koukdjuax River.

Origin of Hudson Strait.

Fox Channel or the southern part of Fox Basin is a continuation of Hudson Strait, and the deep submerged valley in which they lie has a straight north-westerly course of 700 miles. Hudson Bay is comparatively shallow. The bottom is very even and from 70 to 100 fathoms in depth over great areas. Its outlet falls, at right angles,

Soundings.

into the channel of Hudson Strait, in which the soundings range from 200 to upwards of 300 fathoms. The origin of the straight and deep depression in which Hudson Strait and Fox Channel lie, is probably of very ancient geological date. In the great Archæan regions of northern Canada, I have elsewhere shown that the long straight channels of numerous narrow lakes and direct river courses are due to erosion commenced along decomposing dykes of igneous rocks, and that the depressions so formed have, in some cases, been subsequently enlarged from time to time by denudation. Sometimes a group of dykes or fissures produces the same effect as a single dyke. The depression of Hudson Strait and Fox Channel may have originated in this way. My first published suggestion of this is contained in a paper on Glacial Phenomena in Canada, printed in vol. I. of the Bulletin of the Geological Society of America, 1880, p. 300.

Ancient origin.

Erosion along dykes.

In preglacial times, when the northern portion of the continent was elevated considerably above its present level, this valley was situated on the dry land probably as far down as the existing general line of the Atlantic coast, as its depth increases from north-west to south-east or from the interior towards the ocean, and the ice-sheets of the glacial period moved from the high land on both sides directly towards and into it and then down the valley itself, as shown by the striation and the materials of the drift. The few soundings which have been taken eastward of the mouth of the strait would seem to show that its channel continues outward in the same direction, in the bottom of the sea, with comparatively shallow water immediately south of it. This latter section is overlooked by the mountains running in that direction from Cape Chidley. A preglacial river, exceeding in size any of those at present existing in North America and whose branches traversed the dry bed of Hudson Bay, coming together in its north-eastern part, probably flowed down this valley into the Atlantic.*

Direction of movement of ancient glaciers.

Geology of Baffin Land.

In the course of the voyage of the Canadian Government expedition steamer *Neptune* in 1884, and of the *Alert*, sent out on similar service in 1885, I made some notes on the geology of the northern side of Hudson Strait, principally in reference to Big Island and its vicinity.† The results of the work of 1897, embodied in the present report, and which are supplemented by the notes just mentioned, constitute the

Sources of geological information.

* On a Great Preglacial River in Northern Canada. Scottish Geographical Magazine. Volume XI., 1895, p. 368.

† Report of Progress, Geol. Surv. Can., 1882-84, pp. 1-62 DD, and Annual Report Geol. Surv. Can., vol. I. (N.S.) 1885, pp. 1-25 DD.

principal knowledge of the geology of Baffin Land available up to the present time. In Dr. Franz Boas's general description of this great island,* based on his own observations after a residence there of two years, a few notes are given in regard to the geology of some of its northern parts and of the region of its great lakes, which I shall quote, together with a few observations made by others, before proceeding to give the results of my own investigations in the southern part of the island in 1897.

Silliman's Fossil Mount.

A very small outlier of nearly horizontal beds of fossiliferous limestone, shale and marl occurs at the head of Frobisher Bay, in the form of a crumbling hill, resting on the northern flank of the Laurentian range on its south-western side. It was discovered by Captain C. F. Hall and named by him Silliman's Fossil Mount.† Collections of fossils from this hill have been made by different persons. These have all been examined by Mr. Charles Schuchert and reported on by him in a paper on The Lower Silurian (Trenton) Fauna of Baffin Land, in which he gives lists of all the species.‡ They correspond with those which I obtained on Akpatok Island, determined by Dr. Whiteaves § and Mr. Schuchert considers the rocks of both localities to belong to the Galena division of the Trenton group which also occurs on the lower part of the Nelson River, as well as at Stony Mountain and on the west side of Lake Winnipeg in Manitoba. Silliman's Fossil Mount is described as being in latitude 63° 44′, longitude 68° 56′ W., or three miles south of the (mouth of) Jordan River and one mile from tide water. It has a length of 1,000 yards from north-west to south-east, and was ascertained by Mr. R. W. Porter to be 340 feet in height.

Before the fossiliferous limestone at the head of Frobisher Bay was known to be confined to this hill, it was supposed by Dr. Franz Boas, that it might be an extension of the flat-lying limestone of the basin of lakes Amadjuak and Nettilling. It appears now, however, this is not only not connected with the latter, but, judging from the loose pieces which I found in abundance not far from the south side of the former lake, the rocks of the lake region are more probably of middle Silurian age. In 1885, I collected fragments of shaly marl and gray limestone containing fossils of the Trenton group on the surface of ice pans off Big Island. It was thought at the time that these might have come from Trenton beds in some of the bays on the north side of

* Dr. A. Petermanns Mitteilungen, Ergänzungsheft, Nr. 80, November 1885.

† Narrative of the second Arctic Expedition by C. F. Hall, Washington, 1879, Appendix III., on the Geology of Frobisher Bay.

‡ Proceedings of the U.S. National Museum, Vol. XXII., pp. 143-177, No. 1192.

§ Am. Journ. Sci., 4th series, vol. VII. (1899) p. 433.

R. Bell, Photo., 1897.

NEAR BRUCE HARBOUR, LOOKING EAST
Showing characteristic coast scenery

the strait, but the examination of these bays in 1897 proved that no fossiliferous limestone *in situ* occurs there. The fragments referred to corresponded in character with the Trenton marl and limestone of Silliman's Fossil Mount. A good sized stream is described as running through and cutting off a portion of the mount, and this probably carries quantities of marl and limestone débris out upon the shore-ice in spring. As above mentioned, the small icebergs from Pak-a-lui-a on the south-west side of Frobisher Bay, are known by the Eskimos to float from thence through Gabriel Strait, and up the north-east side of Hudson Strait, and the shore-ice, when loosened, would naturally follow the same course. The above facts, taken together, would fully account for the presence of the Trenton fragments on the surface of ice-pans on the northern side of Hudson Strait.

Limestone of Fox Basin.

The scanty information we possess goes to show that Fox Basin is partly bordered on both sides by comparatively low land occupied by undisturbed fossiliferous Silurian limestone. Dr. Franz Boas ascertained the existence of these limestones on Lake Nettilling and he states that southward of the lake they rise into low hill-ranges. He also says: 'We will not be far astray if we connect this extensive Silurian district with the limestones which occur to the south of Igluling and which form the flat eastern half of Melville Peninsula.' Referring to those limestones in a letter to me in 1885, he says: 'The most interesting geological problem of the country is a study of the line of division between the Silurian plains and the eastern highlands. I suppose the Silurian rocks will be found either in the remotest corner of White Bear Sound, or close to it. Probably the strata will be found lying horizontally and then soundings in the lakes Amadjuak and Nettilling will be of great importance. It must be important for the problems of glaciation to survey the *inner* rim of the enormous basin formed by the chain of mountains of Davis Strait, the plateaus of Nugumit, Kingnait, Sikosuilat, Southampton Islands and Melville Peninsula.'

Southampton Island.

Limestones like those of the east and west shores of Fox Basin appear to occur also on the northern side of Southampton Island. I have obtained Devonian fossils from the limestone of the southern side of this large island. A high backbone of Laurentian rocks appears to run through its central part. Fox Basin therefore seems to lie in the middle of a very extensive flat trough of horizontal fossiliferous Silurian limestone, surrounded in a general way on all sides by high Laurentian hills. The Eskimo guide who accompanied me to Lake Amadjuak in 1897, informed me that he had passed round the

Lakes Amadjuak and Nettilling.

western end of the lake and had visited Lake Nettilling. This latter name means 'flat-floor,' and my guide said that flat-lying beds of rock similar to those around Nettilling extend to Lake Amadjuak, as well as to Fox Basin. The fossils which I collected from the horizontal limestones of Mansfield Island in 1884 indicate the Niagara formation, while those occurring in the drift fragments of limestone of similar colour and character, which are abundant for a short distance southward of Lake Amadjuak, belong to the same formation. It is, therefore, probable that the great limestone trough of Fox Basin is chiefly, if not altogether, of Silurian age.

Niagara formation.

Northern Baffin Land.

Referring to the northern parts of Baffin Land, Dr. Franz Boas says: * 'Let us in conclusion cast a glance on the geological structure of the last mentioned territory [the northern part of Baffin Land]. The nucleus of the mountain masses appears to be everywhere gneiss, which I found especially at Kingnait and Panguirtung. In closest combination with the gneiss, granite also occurs, which especially large-grained, appears in the coast ranges and islands, Anarmtung and Newakdjuak in Cumberland Sound; Padloping, Kexertaxdjuin, Nudlung, Tupirbikdjowitjung and Siorartijung on Davis Strait.'

Cumberland Sound.

'In Cumberland Sound, as well as in the Naguimiut plateau, which latter is mostly composed of fine-grained granites, there are found at isolated places, diorites and trap-granulites which have broken through the granite. The occurrence of these to the south on Blunt Peninsula has been confirmed. In Cumberland Sound I found them at Panguirtung, and in a well-marked dyke in Akuliaxling eastward from Kexerten. The same diorite appears also in the mountain Kalingujang to the east of Kingnait.'

Other localities.

'The Silurian limestones overlying the old crystalline rocks, have been already mentioned. The same are found besides in [Cyrus] Field Bay, and they compose nearly the whole northern coast of Baffinland. Hall found sandstone at Lok's Land, which perhaps belongs to the Carboniferous formation. It is said to resemble that found by Parry at Antridge Bay [Fury and Hecla Strait.] Here may also be mentioned the samples of sandstone found by Bessels at Point Garry. From accounts by Captain Walker, of the ship Erik, coal is found in loose boulders in a stream at Eclipse Sound and on Aggidjeu [Durban Island.]'

Rocks of the east coast of Baffin Land.

In the Quarterly Journal of the Geological Society of London, vol. ix., 1853, p. 299, there is a note by Dr. P. C. Sutherland, on the

* Dr. A. Petermanns Mitteilungen Ergänzungsheft Nr. 80, Gotha, Nov., 1885, page 57.

geology of the eastern side of Baffin Land, in which he says the crystalline rocks occupy the whole coast from Cape Walter Bathurst, on the south side of Lancaster Sound to Cumberland Sound, and probably considerably beyond it, and adds: 'To this I believe there is one exception at Cape Durban, on the 67th parallel, where coal has been found by the whalers; and also at Kingnait, two degrees to the south-west of Durban, where, from the appearance of the land as viewed from a distance, trap may be said to occur on both sides of the inlet. Graphite is found abundant and pure, in several islands situate on the 65th parallel of latitude in Cumberland Strait [Sound] and on the west side of Davis Strait.'

Rocks from Cumberland Sound.

In November, 1887, Dr. Franz Boas sent me a small collection of rock-specimens* from the island of Umanaktuak and vicinity on the south-west coast of Cumberland Sound, all believed to have been taken from the rock *in situ*, with the exception of one specimen, which was from a boulder in the bed of a torrent at this island and consisted of 'compact limestone, almost black and somewhat argillaceous. It weathers dark-gray, and shows on the surface slightly projecting fine parallel lines of stratification from one-quarter to one-half inch apart. No trace of fossils can be detected either by inspection or microscopic sections. Under the microscope it is seen to consist of gray, rounded, fine calcareous grains with a few black ones, all apparently deposited from water.†' The other specimens in this collection included the following: 'graphite with rusty surfaces and holding drusy white quartz; a decomposing black crystalline rock, which on microscopic examination, proves to consist of graphite with hornblende, a triclinic felspar and a little quartz; hornblendic gneiss of a rather coarse "pepper-and-salt" appearance consisting of about equal parts of quartz and felspar forming the white portion and of black hornblende with smaller quantities of brown mica, the black; light-gray gneiss of medium texture, composed of about equal parts of orthoclose and quartz, with a subordinate portion of fine scales of black mica; gray gneiss, consisting of layers of mixed orthoclase and quartz, alternating with others composed of scales of brown mica; rusty mica-shist of medium texture, the quartz in small proportions; a very light-coloured variety of granite, apparently from a small vein.' There was also a specimen of foliated graphite with rusty surfaces and partings which had been found by an Eskimo about forty miles inland in a south-westerly direction from Umanaktuak. In connection with my exam-

* Science, vol. X., Dec., 1887, p. 287.

†This would correspond with the rock holding Utica fossils from Frobisher Bay, (noticed further on) as described to me by Professor B. K. Emerson.

ination of this collection, I stated that: 'These specimens indicate the ordinary Laurentian system of much the same character as on the north side of Hudson Strait, where the rocks appear to be allied to those of the lower Ottawa valley, and to be somewhat newer and more modified than the great mass of the Laurentian in the Hudson Bay territories.' My exploration of 1897 amply confirmed this determination of the horizon of the rocks of the north side of Hudson Strait.

Graphite.

On the occasion of the visit of the *Diana* to the whaling station called Black Lead in Cumberland Sound in 1897, specimens of graphite from the neighbourhood were obtained by members of our party. The occurrence of graphite in the various localities above mentioned around Cumberland Sound is interesting in connection with the abundance of the mineral at many places among the crystalline rocks on the north side of Hudson Strait and it is a fact tending to show that the rocks around that sound are also referable to the Grenville series.

Fossiliferous Rocks of Baffin Land.

Rocks from Frobisher Bay

In appendix III., to the 'Narrative of the Second Arctic Expedition made by Charles F. Hall,' (Washington, 1879,) Professor B. K. Emerson, of Amherst College, who examined the geological specimens brought by Hall from Frobisher Bay, enumerates granite, mica-schist, different gneisses, also crystalline limestone, magnetite, apatite, bornite and pyrite. He informs me that the specimens of crystalline limestone appeared to be loose pieces which had been picked up on the shore. They may have been carried from the interior to the bay by the ancient land ice coming from either side of the bay or down the valleys terminating at its head. In any case they indicate an extension in this direction of the crystalline limestones such as I found in great force along the north side of Hudson Strait.

Utica formation.

Silliman's Fossil Mount at the head of Frobisher Bay, already described, was so named by Captain Hall, who also brought Utica and Trenton fossils from localities to the eastward of the Mount and from the north shore of Frobisher Bay. These have been reported upon by Professor Emerson in the above mentioned narrative of Hall's expedition. Small collections of fossils have been brought since Hall's time from Silliman's Fossil Mount by various collectors. All of these, as

Fossils examined by Prof. Schuchert.

well as the Amherst College collection, have been lately critically examined and reported on by Professor Charles Schuchert, of the United States National Museum.* In the last-named collection he finds seven distinctly Utica species in a 'flinty bituminous limestone,'

* On the Lower Silurian (Trenton) Fauna of Baffin Land. Proceeding of the U.S. National Museum, vol XXII., pp. 143-177. With plates XII-XIV.

which Prof. Emerson informs me weathers gray. The locality where these were collected is supposed to be Jones Cape in Frobisher Bay. Hall's collection also contains thirteen Trenton species from Cape Stevens (?) in the same bay. Prof. Schuchert's lists show that 72 species of fossils are now known from Silliman's Fossil Mount and that 28 of these are not known to occur elsewhere. The majority of all the species, or 57 per cent, correspond with those of the Galena or Trenton formation of the Minnesota and Manitoba region, while 17 are known to occur in the Trenton of the Ottawa valley and the State of New York. About 20 of the species are new to palæontology and most of these are described and figured in Prof. Schuchert's paper. He adds: 'The lithological similarities of the Minnesota Galena and Silliman's Fossil Mount, light-coloured shales predominating in both areas, may explain in a large measure the close identity of these widely separated faunas. This little fauna likewise brings out the fact that the corals, brachiopods, gasteropods and the trilobites are slow in their evolutional change, and the species can therefore spread over very large areas, while the cephalopods, and particularly the pelecypods, are more sensitive to change and are thus restricted to localities.... The Baffin Land fauna had an early introduction of Upper Silurian genera in the corals, *Halysites*, *Lyellia*, and *Plasmopora*. In Manitoba similar conditions occur in the presence of *Halysites*, *Favosites* and *Diphyphyllum*. Other Upper Silurian types do not appear to be present.'

Galena formation.

In Minnesota.

The Rev. Edmund Peck, a missionary in Cumberland Sound, obtained from the drift at Lake Kennedy (Nettilling) four species of fossils which may be considered as of Trenton age. They are probably from the eastern extremity of this large lake, which lies close to Cumberland Sound, and if the Trenton occurs *in situ* in that region, it is probably overlain by the Niagara towards the west end of the lake, since that formation would appear to occur there (see ante). Among the Arctic islands northward of Baffin Land large areas of Upper Silurian rocks are known to occur associated with strata of Lower Silurian age.

Fossils from Lake Nettilling.

Laurentian of the North side of Hudson Strait.

The rocks of the northern side of Hudson Strait examined by myself from North Bay to Chorkback Inlet and inland to Lake Mingo consist of well stratified hornblende- and mica-gneiss, mostly gray in colour, but sometimes reddish, interstratified with great bands of crystalline limestones, parallel to one another and conformable to the strike of the gneiss, which in a general way may be said to be parallel to the coast in the above distance. The direction, however, varies

General character of the rocks.

Strikes along the coast.

somewhat in different sections of the coast. On either side of North Bay it appears to converge to a central line running south-south-eastward. From the south-east point of Big Island to Fair Ness the strike is parallel to the shore or about N. 60° W. From Fair Ness to Edmund Bay on the mainland, 25 miles farther to the northward, the direction inclined a little more easterly or inland, being about north-northwest. Here an anticline or a line along which the strike changes, appears to run inland in a north-easterly direction and from this line to the east side of Amadjuak Bay the general strike is about west. Beyond Amadjuak Bay, as far as we went, the strike was pretty uniformly parallel to the trend of the coast or about N. 60° W.

Strikes in th interior.

In going inland from Amadjuak Bay to Lake Mingo, the strike which was at first about north-west gradually changed to about west, which it maintained for the greater part of the distance. A list is given further on showing the direction and amount of the dip together with the character of the rocks in a large number of places along the coast and inland to the north of Amadjuak Bay. It will be seen from this list that except when the strata are vertical, the dip is uniformly to the inland or northward side, except in one part of Markham Bay, and at Macdonald and Rawson islands, where it is in the opposite direction. The character of the rocks being given in each instance in this list no further remarks about them are required. In some instances where the dip was vertical as nearly as could be judged by the eye it is here given as 90°.

Dips of Laurentian Strata, North Side of Hudson Strait. (Astronomical Bearings.) Localities Arranged from South-east to North-west.

Dips of Laurentian strata.

1. West side of Glasgow Island in North Bay. Crystalline limestone and gray gneiss.................................N 34° E < 45°
2. Bruce Harbour, opposite east point of Big Island. Gray gneiss with rusty bands.................................N 16° W < 20° to 60°
3. Prominent hill on east side, Bruce Harbour. Gray gneiss...N 16° E < 35°
4. Twimi Islands, in mid-channel between east point of Big Island and Bruce Harbour. Fine-grain reddish gray gneiss. N 40° E < 45°
5. Middle of north-east side of Big Island. Gray gneiss......N 34° E < 45°
6. East side Reeves Harbour. Gray gneiss.....................N 10° W < 90°
7. North-west side, Reeves Harbour. Gray gneiss..........N 10° to 50° E < 20° to 30°
8. North-east side Ashe Inlet. Dark gray gneiss rather finely ribboned with lighter streaks.................................N 10° E < 30°
9. East side Ashe Inlet. Gray micaceous gneiss.................N 45° E < Mod'te
10. East side Ashe Inlet, 1 mile north-west of Station. Gray gneiss...N < about 25°
11. West side Ashe Inlet. Dark gray gneiss, composed o quartz and felspar in even beds (Rept. G. S. 1884, p 21 DD)....N < 40°
12. East side North Bluff. Dark gray gneiss....................N < low
13. West side North Bluff. Dark gray gneiss..................N 30° W < 10° to 20°

Dips of Laurentian strata.

14. Group of islands 9 miles north of North Bluff. Reddish gray gneiss..N 56° W < 80°
15. Main shore of Big Island 8 miles north of North Bluff. Red and gray gneiss. Disturbed. Average dip..............N 36° W < high
16. The same. 10 miles north of North Bluff. Banded gray and red gneiss..N 10° W < 75°
17. North-east side Big Island near its north-west point. Gneiss and crystalline limestone..............................N 34° E < 40°
18. Central part of Big Island. Common varieties of gray gneiss. (Rept. Geol. Survey, 1884, p. 21 DD.) General dip........N
19. Beaumont Harbour. (Opposite N. W. point of Big Island.) Light-gray crystalline limestone and red-weathering gray gneiss........ .... } N 27° E < at diff't places 15° to 50°
20. South point of entrance to Crooks Inlet. Rusty gneiss with white limestone.......... ....N 38° E < 90°
21. South side Crooks Inlet, between entrance and a point midway up. Brown-weathering or rusty gneiss and light gray crystalline limestone. Average dip.......................N 40° E < 30°
22. South side and upper half of same inlet. Gray fissile gneiss, stained reddish brown, but with yellow patches and associated with several thick bands of crystalline light coloured limestone.................................. } N 33° E Average < 45°
23. Large promontory of north side of same inlet. White crystalline limestone ....N 28° E< 30° to 45°
24. 2 miles inland (N.) from head of same inlet. Gray gneiss....N 30° E < 60°
25. 3 miles inland from, Do. Gray gneiss......................N 23° E < 50°
26. Bay opposite east end Strathcona Islands. White crystalline limestone and dark hornblendic gneiss ....N 14° E < 25°
27. Promontory at Red Islands, opposite middle of Strathcona Islands. Rusty gray gneiss with crystalline limestone . { N 14° E to N 34° E < 45°
28. Island off south-east point of Glencoe Island. Gray gneiss...N 14° E < 30°
29. Mainland opposite east end Glencoe Island. Rusty decomposing micaceous gneiss, also crystalline limestone.......N 24° E < 25°
30. Mainland, opposite west end of Glencoe Island. Gray gneiss.N 14° E < 25°
31. Wharton Harbour. Great band of white crystalline limestone running E.S.E. up a valley........... ....N 24° E < 60°
32. Spicer Island. Light-gray quartzose gneiss, some of it holding light purple garnets.. ....N 24° E < 90°
33. Entrance to Akuling Inlet. Gray gneiss........ .. - ..... 24° E < 60° to 80°
34. West side Akuling Inlet. Gray gneiss......................N 29° E < 60°
35. First point south of Bedford Harbour. Gray gneiss........N 34° E < 45° to 60°
36. Cape Montrose, Markham Bay. Gray gneiss...............N 34° E < 45°
37. Between Bedford Harbour and Fair Ness. Gneiss and limestone streaked with red.......... ....N 34° E < 45° to 60°
38. East side of Bedford Harbour. Gray gneiss...... .. ....N 34° E < 60°
39. West side Bedford Harbour. Bedded felspar and quartz rock, with red rusty streaks...........................N 14° E < 75°
40. Beds of white crystalline limestone and felspar alternating with gneiss or schist, weathering rusty red .... { N 34° E < 40° to 70°
41. Ta-muck-ta-may (or south bight of Markham Bay). Gneiss interstratified with crystalline limestone.... ....N 30° to 40° E < 45°
42. Around Blandford Bay. Crystalline limestones and associated red-weathering rocks........... .... { N 35° E < about 40°
43. Near Point Robert, Markham Bay. Gneiss and crystalline limestone.. { S 80° W Average < 45°

Dips of Laurentian strata.

44. Albert Bay, near centre of Markham Bay. Gray gneiss with white beds (limestones ?)........ S 80° W < 90°
45. Island between Albert and Lubbock Bays. Gneiss and light gray limestone, much oxidized........ S 80° W < 80°
46. Long Island at entrance of Lubbock Bay. Grey gneiss containing much light purple garnet as disseminated crystals. N 59° E < 90°
47. Head of Lubbock Bay. Medium and fine-grained massive gray gneiss, hummocky and much oxidized........ N 14° E < 90°
48. North-eastern of the Islands of God's Mercie. Gray gneiss.. N 10° W < 45°
49. Peck Island in Edmund Bay. (Next west of white Bear Bay.) Rather fine-grained light gray quartzose gneiss........ N 6° W < 90°
50. Point opposite (N.E. of) Macdonald Island. Gray gneiss... N 10° W < 60°
51. Macdonald Island. Gray gneiss........ S 10° E < 25°
52. Small island 5 miles north of Macdonald Island. Light reddish gray gneiss........ S 84° W < 70°
53. Top of knob 450 feet high at mouth of Alice River. Gray gneiss. N 34° E < 90°
54. Rawson (Harbour) Island. Gray gneiss........ N 6° W < variable and high
55. Island 13 miles S.W. of Rawson Island. Gray gneiss........ S 17° W < 70°
56. Fairfax Harbour, near Tilted Hat Mountain. Gray gneiss.. N 44° E < 65°
57. Geikie Point, near Chorkback Inlet. Gray gneiss........ N 34° E < 60°
58. Around Port DeBoucherville on southern point of Nottingham Island. Gray and reddish gneiss. (Rept. Geol. Survey, for 1884, p. 28, DD.) Average dip........ N 45° W < high

Between Amadjuak Bay and Lake Amadjuak.

59. Gertrude Lake, midway up. Gray gneiss........ N 80° E < 90°
60. Head of Gertrude Lake. Band of light crystalline limestone and felspar about 1000 feet thick immediately overlying rusty gneiss........ N 54° E < 60°
61. Orton Lake. White limestone. Local dip........ N 12° E < 70°
62. White-streak Mountain, part of Franz Boas Lake. Band of white limestone of great thickness. General dip........ N 56° E < 90°
63. Foot of Greely Lake. Gray gneiss........ N 19° E < high
64. East side Greely Lake, opposite Boulder River. Gray gneiss. N 14° E < high
65. Portage between Stevenson and Gilbert Lakes. Gray gneiss. N 11° W < 90°
66. Between Gilbert and Walcott Lakes. Gray gneiss. General dip........ N 34° to 64° E < high

It will be seen from the above list that the dip is often vertical or nearly so and that in the great majority of cases it is inland or northward, being in the opposite direction at only two localities.

Crystalline Limestones.

The distinguishing feature in the geology of the southern part of Baffin Land is the great abundance, thickness and regularity of the limestones associated with the gneisses. At least ten immense bands, as shown on the accompanying map, were recognized, and it is probable that the two others, discovered in North Bay, are distinct from any

R. Bell, Photo., 1897.

FORKED FALL AT THE HEAD OF CANYON INLET, 468 FEET HIGH.

Crumbling white crystalline limestone on the left.

of these. There would, therefore, appear to be twelve principal bands as far as known, to say nothing of numerous minor ones, between Icy Cape and Chorkback Inlet. The limestones are, for the most part, nearly white, coarsely crystalline and mixed with whitish felspars The individual crystals in some parts of the limestone masses would measure two or three inches in diameter and the crystallization of the felspar is occasionally equally coarse. The latter is generally somewhat irregularly disseminated, but sometimes it has a sort of parallelism with the bedding, although seldom entirely unmixed with the limestone. The limestones usually contain scattered grains of graphite and among the other minerals which commonly occur in the various bands are mica, garnet, magnetite, pyrite and hornblende. Serpentine of a dark colour was abundantly disseminated as grains and small irregular masses in a band which crosses the head of Cañon Inlet. Disseminated specks of bright green and blue serpentine were found in another band at White Bluff Harbour and similar specks of both colours occur in the eastern band at the head of North Bay. The late Mr. Ashe gave me a crystal of sphene, an inch and a half in diameter, which had been brought to him by an Eskimo from North Bay—probably obtained from the limestone there.

Twelve bands.

Associated felspars.

Included minerals.

Although white is the prevailing colour of these limestones, this, in some localities is replaced by light-gray and occasionally by mottled varieties. The coarsely crystalline band which forms the (three small) Red Islands, opposite the Strathcona Islands, has a uniformly salmon-red or flesh colour. Some handsomely variegated kinds are to be found on the point just west of Glasgow Island in North Bay.

Colour.

The limestone bands have not suffered greater denudation than the gneisses, and they form hill and dale alternately with the latter. It is not easy to fully explain why the limestones have not been more deeply eroded than the gneisses, as is the case with the limestone bands in the counties of Ottawa, Labelle and Argenteuil on the north side of the Ottawa River, but the difference may be due partly to the limestone being more solid or having fewer joints and fissures than the gneisses, thus preventing the entrance of the surface waters which caused deeper decay in the latter during preglacial times, and partly to the fact that the dip is inland or northward from the strait, or directly towards the advance movement of the ice, and that this circumstance would shield every band from its denuding action. On the other hand, in the lower Ottawa region, just referred to, the run of the limestone bands corresponds to the direction of the glaciation and this has

No special erosion of the limestones.

Possible reasons.

favoured the wearing out of the valleys by the movement of the ice and its accompanying rock-débris.

Limestones are conspicuous.

Owing to the scantiness of the vegetation in Baffin Land, the white colour of the limestones on the sides and tops of the hills and ridges renders them very conspicuous in the landscape. Seen from a hill-top at a distance of fifteen or twenty miles they might be mistaken for glaciers. The débris of the decomposing limestones forms crumbling slopes resembling coarse salt on a grand scale. Among the localities where these limestone bands are well exposed, may be mentioned the head of North Bay, the north-east side of the upper part of Big Island and the adjacent islands as well as the mainland opposite, on both sides of Crooks Inlet, at the entrance to Cañon Inlet, on the Strathcona Islands and main shore opposite, around the northern and eastern parts of Markham Bay, at Wharton Harbour, Akuling Inlet, islands off Fair Ness, Aberdeen Bay, and along the shore southward of Amadjuak Bay; also along the route from this bay to Lake Amadjuak, at Orton Lake and White-streak Mountain at the foot of Franz Boas Lake. The high slopes about the north-western end of Big Island, were the first examples we saw of these white limestones, and at first sight we supposed the light colour to be due to snow on the hill-sides.

Localities of limestones.

Crooks Inlet.

Crooks Inlet is about twenty miles in length and it crosses the general strike at right angles. About half the total length of its shores appear to consist of crystalline limestones belonging to five different large bands. Owing to the shortness of the time at my disposal and the necessity of hastening to explore the coast to the north-westward, it was impossible for me to measure the width of these bands, but as the dips were at considerable angles and always in the same direction, (north-eastward), it was estimated that their total thickness may be 20,000 feet, if not more. The wide and conspicuous bed of coarsely crystalline whitish limestone and felspar, which runs from Wharton Harbour east-southeastward up a valley, afforded a better opportunity for estimating the thickness than any of the other bands we saw. It appeared to have a horizontal width of a mile and a quarter, or 6,600 feet. The dip is northward at an angle of about 60° and hence the bed would have a thickness of about 5,700 feet at right angles to the stratification.

Thickness.

As to the total thickness of the twelve bands of crystalline limestone which have been mentioned as occurring in this part of Baffin Land, the available data on the subject are not sufficient to form a correct estimate, but on adding together their probable approximate widths it seems to be no exaggeration to place their possible total volume, great

Total volume.

as it may appear, at about 30,000 feet, or an average of 2,500 feet for each of the principal bands, taking no account at all of the smaller ones.

It was stated in my summary report on the geology of this region that the series of rocks under consideration, including the limestones, seems to be made up of altered sediments. The enormous thickness, great length and regularity of the limestone bands would show that they have been precipitated evenly on the level bottom of the primeval ocean, and further that the sea must have been deep and the conditions uniform for great lengths of time. At the period when the limestones were formed, the temperature and the composition of the sea were no doubt very different from what they have been in the later geological times, and the precipitation of such vast quantities of carbonate of lime may have been due to such causes as the mingling of ocean currents with slight differences in the composition of their waters, the ebullition of gases from the bottom, or possibly from some change in the temperature of that part of the sea. Sedimentary origin.

Thin, short and uneven layers of limestone consisting of lenticular and nodular forms along a certain plane in the stratification of large masses of crystalline rocks containing lime, may have been formed by concretionary action during or subsequent to consolidation, but in the present case, apart from the above reasons, the bands are too thick in proportion to the interstratified rocks to favour such an hypothesis, even if the minerals entering into the composition of the gneiss contained any considerable amount of lime in any form, which they do not. Concretionary action.

The ten large and parallel bands of limestone which have been described, in their extension to the south-eastward, probably continue to curve to the southward, eventually coming out upon the shore of the strait at various places between North Bay and the Middle Savage islands. In 1884, while seeking for a suitable place at which to establish an observatory station, the expedition steamer *Neptune* coasted as near as possible to the land, from the Middle Savage islands to Cape Best or Hattons Headland and we went ashore at some points. I had then an opportunity of seeing that the rocks in this interval of coast were Laurentian gneisses which showed considerable regularity in their stratification. It has been already mentioned that among Captain C. F. Hall's specimens from Frobisher Bay, crystalline limestone and apatite occur, and although these were probably picked up as loose fragments, they indicate the occurrence of these minerals *in situ* within the watershed of this bay and they are further evidence South-east extension of limestones. Crystalline limestone at Frobisher Bay.

of the extensive development of the Grenville series in the southern part of Baffin Land.

Associated rocks.

The limestones are constantly associated with rocks which, in the fresh state, seem to consist of thinly laminated micaceous and graphitic gneiss, but which upon the surface generally appear as decomposed reddish brown ochrey masses with yellowish patches, the whole being the result of the action of the weather upon the pyrite which is abundantly disseminated throughout these strata. The hills formed of such rocks adjoining the limestone bands often look like great heaps of brownish ochre. By digging through the soft oxidized surface the partially decomposed pyritiferous rock containing much graphite can generally be reached at the depth of a few feet. Boulders are usually absent from these hills. The crystalline limestones of the Grenville series on both sides of the Ottawa River have decomposable rocks like the above associated with them and this constitutes an interesting resemblance pointing to a correspondence in age of the two sets of rocks. I have no doubt that a more detailed examination of the Baffin Land series would bring out other points of resemblance tending to prove their contemporaneity. If this were established it would be of great importance, since the rocks of the Grenville series are known to be elsewhere productive of a variety of economic minerals.

Ochrey covering.

Surface Geology.

Erratics.

In the portion of Baffin Land explored by myself, there is abundant evidence of the former existence of land-ice in the form of till and rounded and angular erratics. The latter are generally, but not universally, scattered in great numbers upon the surface of the rocks alike on the hills and lowest grounds. The rounded boulders are often thrown together in immense quantities, without any admixture of finer material, in the shape of ridges and heaps like small hills, especially along the sides and towards the bottoms of valleys. In some cases, as at Boulder River, Stevenson Lake, they are spread evenly and continuously over many acres, completely concealing the rock or ground beneath. They may generally be seen conspicuously perched on the flanks and tops of hills and on the brinks of precipices. Frequently they are gathered into groups in a variety of situations. With few exceptions the boulders at any place throughout the country consist of gneisses like those of the surrounding district and they have probably not been transported any great distance. Very large boulders are not common and few of extraordinary size were seen.

How they occur.

Osars.

Osars or dry heaps and ridges of sand and gravel without boulders

R. Bell, Photo., 1897.

LOOKING DOWN CANYON INLET FROM ITS HEAD.
A heap of glacial débris in foreground.

or even large stones were seen at several places on my journey to Lake Amadjuak, especially about the northern part of Stevenson Lake and west of Gilbert Lake. The till was nearly always much oxidized and it partook of a gravelly and sandy rather than a clayey character in the great majority of cases. It was present in considerable quantities at the head of inlets and on the slopes or the bottoms of most of the valleys examined. On our tramp to and from Lake Amadjuak we walked most of the way along the bottoms and sides of valleys, and here one of the characteristic features was the frequency with which our course was crossed by rivulets of perfectly transparent icy water, gurgling over stony bottoms in narrow channels cut through the till. Their flow appeared to be regular and constant and their supply of water seemed to be derived from the gradual thawing, during the summer weather, of the frozen ground along the numerous branches of the rivulets on the higher parts of the valley-slopes.

Till.

Many rivulets.

The general contours of the hills show that the country has been ice-swept at some period, but the other distinct signs of glaciation are not so strongly marked as they are along the eastern coast of Hudson Bay, or more particularly on the northern shores of Lakes Huron and Superior. The ochrey covering on many hills resulting from the superficial decay of certain rocks which accompany the great limestone bands has been already described. This is an evidence that these hills have not been recently glaciated. The frequent, if not general absence of boulders on such hills is an interesting circumstance in this connection. The surfaces of the gneisses exposed to the weather on the hills in various places where I went inland was considerably eroded, leaving the more resisting layers standing out several inches above the general surface.

Glaciation.

Distinct glacial striæ were seldom seen and then, as a rule, only near the level of the sea or of some lake. The bearings, in such cases as were observed, are given in the following list. In the interior, the general tendency of the striæ appears to be to follow the lowest levels towards Hudson Strait, while on the shore of the strait itself the glaciation has been south-eastward or parallel to its general course. On the southern side of the strait similar phenomena occur, that is, the glaciation runs from the interior northward to this great channel and on reaching it turns down its course towards the Atlantic. It would appear that before the advent of the glacial epoch this part of the continent stood at a considerably greater elevation above the ocean than the present, and that the bed of Hudson Strait and its continuation in the deep water of the southern part of Fox Basin, formed a straight land valley about 100 miles wide and 700 miles long, reaching

Glacial striæ.

Submerged valley of Hudson Strait.

from the Frozen Strait to the line of the present Atlantic coast of Labrador. This now submerged valley deepens as it goes towards the Atlantic, and as shown by the surroundings, its bottom is much lower than that of Hudson Bay. As I have elsewhere mentioned* the glaciation along the northern part of the present bottom of the eastern side of the latter was northward. The glacier which filled the valley now occupied by Hudson Strait would thus derive a portion of its ice from the bed of Hudson Bay.

Drift of Nottingham Island.

Before the discovery of direct evidence of the northward movement of the ice in the north-eastern part of the bed of Hudson Bay I suggested that the débris of rocks of the Manitounuck formation of the East Main Coast, which forms nearly half of the drift material on the southern part of Nottingham Island and embracing all varieties of the rocks of the series, might have come from somewhere to the west of this island†, but with our present knowledge on this subject, it appears more probable that the material has been derived from the eastern coast of Hudson Bay, as Nottingham Island would lie directly upon the course of the ice coming from this coast.

Terraces.

Wherever soft materials occur in the situations which were exposed to the action of the waves when the sea stood at relatively higher levels, or rather when the land was depressed, terraces may be seen marking periods of rest during the general uprising of the land which has been going on since the glacial epoch, and still continues. The time at my disposal did not permit of much attention being paid to this branch of the geology of the region explored, but a few facts were noted. At one mile north from the head of Crooks Inlet an ancient gravel and sand beach occurs at 360 feet above the sea, according to the barometer. A remarkable terrace with an inward semicircular curve stretches from side to side of a valley at a distance of about two miles from the shore, eastward of Glencoe Island. On a mountain side, half a mile west of Akuling Inlet and one mile in from the entrance, old beaches or terraces, marked by gravel, sand and rounded stones occur at 378 and 528 feet above high tide as determined by the barometer. At Ta-muck-ta-may, a bay on the south side of Markham Bay, there are wide, sandy and gravelly plains behind the present sea-shore and overlooking the same small bay a remarkable set of terraces on a north-facing slope, occur at various elevations up to about 400 feet. Distinct terraces were seen at different heights around the lakes of the chain drained by Alice River, which

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* On Glacial Phenomena in Canada, Bull. Geol. Soc. of Am., vol. I., 1890, p. 298. Report of Progress Geol. Surv., Can., 1882-3-4, p. 37, DD.

† Report of Progress, Geol. Surv., Can., 1882-3-4, p. 29, DD.

was followed on our way to Lake Amadjuak. In connection with this subject, Mr. Drinkwater of the *Diana* expedition, informed me that he had climbed the hills above O'Brien Harbour at Cape Chidley, and found a horizontal line of rolled stones, plainly marking a raised beach at an elevation of about 600 feet above the sea.

Pleistocene fossils.

Little could be done in the way of searching for fossils in the pleistocene deposits, but shells of *Saxicava rugosa* and *Mya truncata* were noticed in the till in a valley on the north-eastern of the Islands of God's Mercie at 200 feet from the sea, and at Lakes Gertrude and Greely *Saxicava rugosa* occurred in the drift at 110 feet above the same level in each case. At one place on the former lake the stony clay had been pushed and disturbed by ice since the shells were deposited. In all the harbours and sheltered places where we anchored we found a stiff stony clay and mud bottom at convenient depths.

Giant pot-holes.

Giant pot-holes in gneiss were observed on the west-facing slope at the east side of the narrow entrance to Cañon Inlet, of the following dimensions in the order of their occurrence from the extremity of the point southward : One between high and low tide, 8 feet in diameter ; one of hollow spherical form and 15 feet in diameter, partly open at the side, whose top was 30 feet above tide ; one between high and low tide, 20 feet in diameter, and one with top about 50 feet above tide, and about 18 feet in diameter

Glacial Striæ, North Side of Hudson Strait, Astronomical Bearings.

1.	Northern Inlet of North Bay	S. 27° W.
2.	Around Ashe Inlet (Rept. of Geol. Surv, 1885, p. 22, DD)	S. 65° E.
3.	Crystalline limestone ridge across entrance to Cañon Inlet, the striæ run up and over a steep slope	S. 34° W.
4.	West side Big Island, 9 miles north of North Bluff, about	S. 15° E.
5.	Entrance to Akuling Inlet	S. 57° W.
6.	North side Albert Bay, Markham Bay	S. 34° W.
7.	Amadjuak Harbour	S. 34° W.
8.	Gertrude Lake	S. 4° W.
9.	Foot of Franz Boas Lake	S. 39° W.
10.	Foot of Greely Lake	S. 44° W.
11.	Walcott Lake	S. 59° W.
12.	Top of a mountain 1 mile S.W. of Mount Mingo and facing N.E.	S. 54° W.
13.	Rawson Harbour Island	S. 54° W.
14.	North-eastern of the Islands of God's Mercie, on vertical wall and rounded rocks	S. 44° W.
15.	Eastern sides of Islands of God's Mercie	S. 11° W.
16.	Long Island lying across entrance to Lubbock Bay, up steep slope and over the rounded ridge of the island	S. 59° W.
17.	Head of Lubbock Bay	S. 16° E to S 24° W.
18.	Fairfax Harbour (on mainland 5 miles east of Hobart Island).	S. 54° W.
19.	North end of Jubilee Island	S. 49° W.

20. Geikie Point, near Chorkback Inlet........................	S. 4° W.
21. Low southern extremity of Nottingham Island. Average of 20 situations around Port De Boucherville. (Rep. Geol. Survey, 1885, p. 29, DD)...........................	S. 87° E.
22. In a valley at the head of Port De Boucherville. (Rep. Geol. Surv., 1885, p. 29, DD) about..........................	S. 45° E.

APPENDIX I.

Astronomical Observations.

Latitudes in Baffin Land from observations by Dr. Robert Bell, in 1897 used in the compilation of the accompanying map of Hudson Strait.

1.	Sunday,	22nd August,	1897..	Latitude	64° 14′ 19″
2.	Wednesday,	11th "	1897..................	"	63° 57′ 57″
3.	"	18th "	1897..................	"	63° 58′ 07″
4.	Monday,	23rd "	1897..................	"	63° 44′ 33″
5.	Saturday,	31st July,	1897..................	"	63° 17′ 28″
6.	Wednesday,	25th August,	1897..................	"	63° 08′ 20″
7.	Tuesday,	27th July,	1897..................	"	63° 00′ 42″
8.	Friday,	27th August,	1897..................	"	62° 45′ 35″
9.	Friday .	13th "	1897..................	"	64° 18′ 35″
10.	Saturday	14th "	1897..................	"	64° 25′ 02″

Localities of the above Observations.

1.—Point S. 4° E., 2½ miles from southwest end Diamond Island.
2 and 3.—In harbour, at head of Amadjuak Bay.
4.—Point N. 25° E., 4 miles from north end of Hector Island.
5.—On Spicer Island, 1 mile from north end.
6.—Point N. 60° W., 12 miles from northwest end Glencoe Island.
7.—Point on shore, N. 26° W., 5 miles from Cape Colmer.
8.—Point due south 4 miles from west end Emma Island.
9.—On Amadjuak Lake route, at north end of Gilbert Lake.
10.— " " 1½ miles south of Mount Mingo

LONGITUDES in Baffin Land from observations by Dr. Robert Bell in 1897, used in the compilation of the accompanying map of Hudson Strait.

	Calculations by J. G. G. Kerry, McGill University.				Revised Results from Corrected Latitudes.		
Number.	Date.	Assumed Latitude.	Approx. Long.	Reduced Longitude.	Corrected Latitude.	Long'de.	Difference with map.
	1897.						
1	Aug. 22	64° 10′	75° 00′	73° 29′ 39″	64° 06′ 10″	73° 33′ 29″	Abt. ½ mile E.
2	" 10	64° 20′	75° 30′	72° 26′ 49″	63° 50′ 22″	72° 56′ 27″	" ½ " W.
3	" 23	64° 00′	73° 00′	72° 52′ 57″	63° 49′ 23″	73° 03′ 34″	" ½ " W.
4	" 25	63° 10′	71° 00′	71° 33′ 49″	63° 00′ 11″	71° 43′ 38″	" 4½ " W.
5	" 27	62° 55′	71° 00′	70° 56′ 21″	62° 47′ 45″	71° 03′ 36″	" 5⅔ " W.

Localities of the above observations.

1.—Point N. 78° E. 3 miles from west end Chamberlain Island.
2.—Point N. 14° W. 4½ miles from north end McDougall Island.
3.—Point S. 4° W. 7½ miles from Rawson Harbour.
4.—Point S. 25° W. 3½ miles from northwest end Glencoe Islands.
5.—Point S. 28°. 2½ miles from west end of Emma Island.

APPENDIX II.

LIST OF PLANTS COLLECTED IN HUDSON STRAIT BY DR. ROBERT BELL IN 1897.

The Phænerogams determined by J. M. Macoun, the Cryptogams by Prof. John Macoun.

The first column in the following list includes the species found around Prince George's Sound on the south side of Hudson Strait;

the second column the species collected in Baffin Land between Amadjuak Bay and Chorkback Inlet.

	I.	II.
Ranunculaceæ.		
Ranunculus nivalis, L.	*	....
" pygmæus, Wahl	*	....
" hyperboreus, Rottb.	...	*
" affinis, R. Br.	....	*
Papaveraceæ.		
Papaver alpinum, L.	*	....
Cruciferæ.		
Cardamine pratensis, L.	....	*
" bellidifolia, Hook	*	....
Draba nivalis, Lilj	*	....
" Wahlenbergii, Hartm	....	*
Arabis alpina, L.	....	*
Eutrema Edwardsii, R. Br.	*	....
Caryophyllaceæ.		
Silene acaulis, L.	*	....
Lychnis affinis, Vahl.	*	....
" apetala, L.	....	*
Stellaria longipes, Goldie.	....	*
Cerastium alpinum, L	*	*
Leguminosæ.		
Oxytropis campestris DC. var. cærulea, Koch	*	....
" leucantha, Pers	....	*
Rosaceæ.		
Rubus Chamæmorus, L.	*	....
Potentilla nana, Willd	*	....
Dryas integrifolia, Vahl	*	*
Saxifragaceæ.		
Saxifraga oppositifolia, L.	*	....
" Aizoon, Jacq	....	*
" cæspitosa, L.	....	*
" rivularis, L.	....	*
" cernua, L.	....	*
" nivalis, L.	....	*
" stellaris, L. var. comosa, Poir.	....	*
" Hirculus, L.	*	*
" tricuspidata, Retz.	*	*
" aizoides, L.	....	*
Onagraceæ.		
Epilobium latifolium, L.	*	*

	I.	II.
Compositæ.		
Erigeron uniflorus, L.	*	*
" eriocephalus, J. Vahl	....	*
Antennaria alpina, Gærtn.	....	*
Arnica alpina, Olin.	*	*
Chrysanthemum arcticum, L.	...	*
Artemisia borealis, Pall.	....	*
Taraxacum officinale, Weber. var. alpinum, Koch	*	*
Campanulaceæ.		
Campanula uniflora, L.	*	*
Ericaceæ.		
Vaccinium uliginosum, L.	*	*
" Vitis-Idæa, L.	*	....
Arctostaphylos alpina, Spreng.	....	....
Cassiope tetragona, Don.	*	....
Loiseleuria procumbens, Desv.	....	*
Bryanthus taxifolius, Gray	*	*
Ledum palustre, L.	*	....
Pyrola minor, L.	....	*
Plumbaginaceæ.		
Armeria vulgaris, Willd	*	*
Scrophulariaceæ.		
Pedicularis Lapponica, L.	*	....
" Langsdorffi, Fisch. var. lanata, Gray.	..	*
" hirsuta, L.	*	..
" flammea, L.	*	*
Polygonaceæ.		
Polygonum viviparum, L.	*	*
Oxyria digyna, Hill.	*	*
Cupuliferæ.		
Betula glaudulosa, Michx.	*	....
" nana, L.	*	....
Salicineæ.		
Salix arctica, R. B.	....	*
" glauca, L.	*	....
" herbacea, L.	....	*
" reticulata, L.	*	*
" myrsinites, L. var. parviflora, Pursh	...	*
" Uva-ursi, Pursh.	....	*
" Richardsoni, Hook.	....	*
Empetraceæ.		
Empetrum nigrum, L.	...	*

	I.	II.
Liliaceæ.		
Tofiledia borealis, Wahl	*	*
Juncaceæ.		
Luzula spicata, Desv	*	
Cyperaceæ.		
Carex misandra, R. Br	..	*
" saxatilis, L	*	*
Eriophorum Scheuzeri, Hoppe	....	*
Gramineæ.		
Glyceria vilfoidea, Fries	*	....
Arctagrostis latifolia, Griseb	..	*
Hierochloa alpina, R. and S	*	....
Alopecurus alpinus, L	*	*
Equisitaceæ.		
Equisetum arvense, L	....	*
Lycopodiaceæ.		
Lycopodium Selago, L	....	*
Musci.		
Ceratodon purpureus, Brid	....	*
Racomitrium lanuginosum, Brid	....	*
Barbula fragilis, Bruch and Schimp	...	*
Amphoridium Lapponicum, Schimp	....	*
Tetraplodon mnioides, Bruch and Schimp	.	*
Webera nutans, Hedw	....	*
Bryum arcticum, Bruch and Schimp	....	*
Aulacomnium palustre, Schwær	....	*
Lichens.		
Cetraria islandica, (L.) Ach	....	*
" nivalis, (L.) Ach	....	*
Alectoria jubata var. chalybæ formis, Ach	....	*
" ochroleuca var. rigida, Fr	...	*
Umbilicaria proboscidea, (L.)	....	*
" hyperborea, Hoffm	....	*
Peltigera aphthosa, (L.) Hoffm	....	*
Solorina crocea, (L.) Ach	*	....
Placodium vitellinum (Ehrh)	....	*
Placodium elegans (Link.) DC	....	....
Lecanora pallescens, (L.) Schær	....	*
Pertusaria glomerata, (Ach.) Schær	....	*
Stereocaulon paschale, (L.) Fr	....	.. .
" condensatum, Hoffm	....	*
Cladonia rangiferina var. sylvatica, L	....	*

Fungi.

Scleroderma, sp.
Lycoperdon Belli, Peck. Collected also at Digges Island, south side Hudson Strait.

APPENDIX III.

List of Lepidoptera taken in Baffin Land by Dr. Robert Bell, in 1897.

Determined by Dr. James Fletcher, Government Entomologist, Ottawa.

July 23.—Big Island :—
Argynnis Chariclea, Schneid, (4 specimens).
Colias Hecla, Lef. Female.

July 25.—Beaumont Harbour :—
**Chionobas Taygete*, Hub. Male.
Colias Hecla, Lef. Male.
Lycæna Aquilo, Bdv. (=*L. Franklinii*, Curtis).
Argynis Chariclea, Schneid. (4)
Anarta Richardsonii, Curtis. Female.
Laria Rossii, Curtis, (Larva).

July 26.—Head of Crooks Inlet :—
Argynnis Chariclea, Schneid, male and female.
" *Polaris*, Bdv.
Colias Hecla, Lef. 3 males and female.
" *Pelidne*, Bdv. 3 males.

July 27.—*Lycæna Aquilo*, Bdv.
Argynnis Polaris, Bdv. One male and one female.

July 29.—Koong-neow Inlet :—
Chionobas Assimilis, But. Female.
Colias Pelidne, Bdv. Female.

August 12.—Route from Amadjuak Bay to Lake Amadjuak :—
Chrysophanus Hypophlœas, Bdv.
Lycæna Aquilo, Bdv.

August 14.—Near Lake Mingo :—.
Chrysophanus Hypophlœas, Bdv.
Colias Nastes, Bdv.
" *Hecla*, Lef. Male.
Anarta Richardsonii, Curtis.

Two species of bumble-bees were also collected which Dr. Fletcher has determined as *Bombus strenuus*, Cr. and *Bombus sylvicola*, Kirby.

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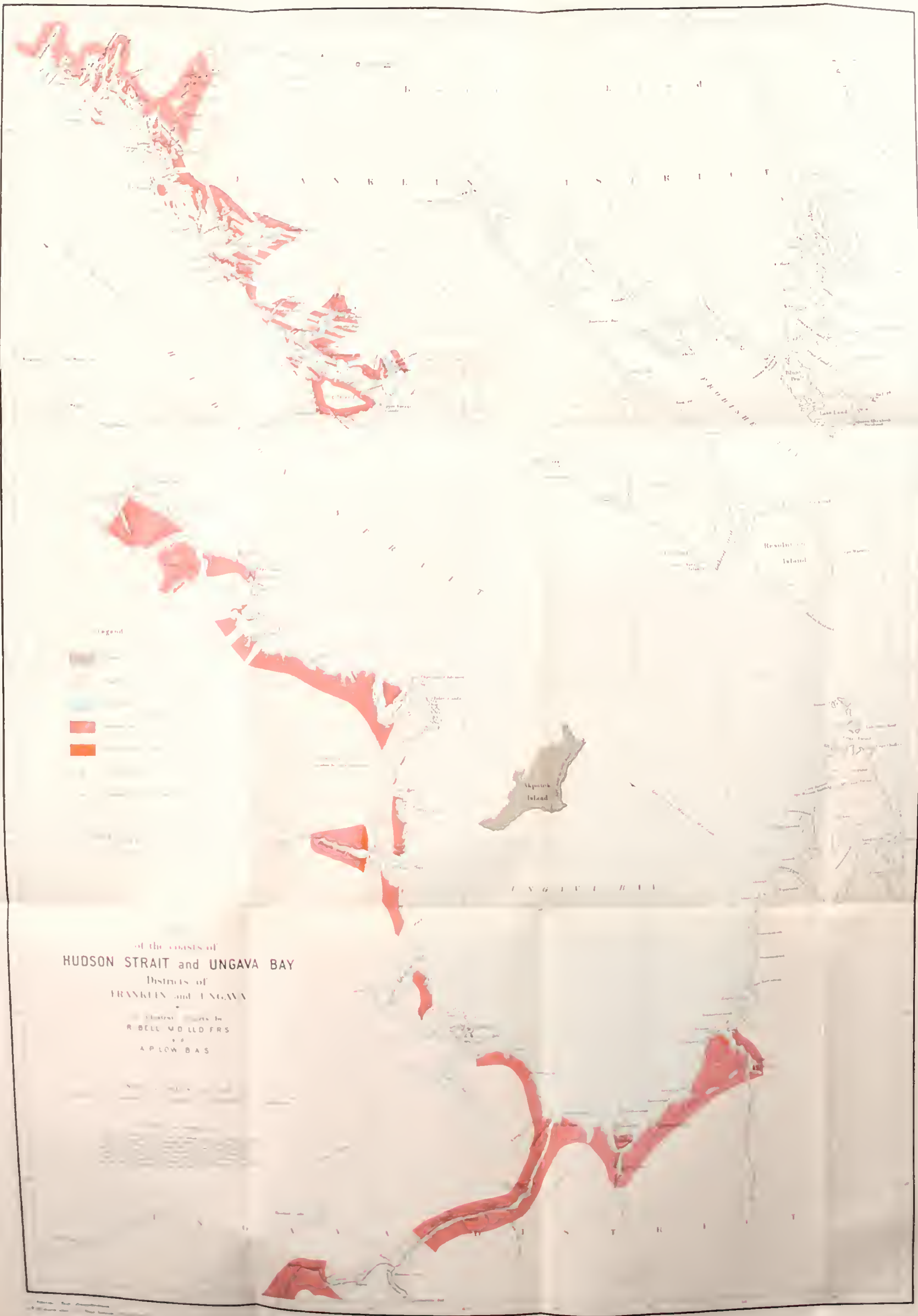
* Although this species is quite within the range where it might be expected to be found, this, I believe, is the first actual Canadian record published.—J. F.


of the coasts of
HUDSON STRAIT and UNGAVA BAY
Districts of
R BELL M D LL D F R S
A P LOW B A S
Akpatok Island
Resolution Island
Legend

GEOLOGICAL SURVEY OF CANADA

G. M. DAWSON, C.M.G., LL.D., F.R.S., Director

REPORT

OF THE

SECTION OF CHEMISTRY AND MINERALOGY

BY

G. CHRISTIAN HOFFMANN, LL.D., F.I.C., F.R.S.C.,
Chemist and Mineralogist to the Survey.

Assistants

F. G. Wait, M.A., F.C.S.
R. A. A. Johnston.

OTTAWA
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EXCELLENT MAJESTY
1900

695.

To

G. M. Dawson, C.M.G., LL.D., F.R.S.,

Director of the Geological Survey of Canada.

Sir,—In handing you the accompanying report, I should mention that it does not by any means represent all the work accomplished in this Laboratory during the period which it embraces—indeed but little more than half, the balance, possessing but little or no interest save to those on whose behalf it was carried out, having been altogether excluded.

Many of the minerals, et cetera, referred to in the following pages are, as may be readily inferred from the descriptions and analyses given, of considerable economic importance, owing to their application in the Arts and Manufactures.

I have the honour to be,

Sir,

Your obedient servant,

G. CHRISTIAN HOFFMANN.

Ottawa, November 11, 1899.

TABLE OF CONTENTS.

REPORT

OF THE

SECTION OF CHEMISTRY AND MINERALOGY.

MISCELLANEOUS MINERALS.

1. Celestite.

A milk-white, pearly, translucent, radiating columnar, massive celestite, is met with, forming a vein traversing Laurentian strata, on the seventh lot of the tenth concession of the township of Bagot Renfrew county, in the province of Ontario. The vein, which has been traced for over two hundred yards, has been stripped at several points along its course for a distance of some sixty feet and found to have a width of from eight to ten feet. There are also indications, it is said, of the existence of another vein of this mineral running parallel with, and not far removed from, this one.

Mr. R. A. A. Johnston found the mineral to have a specific gravity, at 15·5° C., of 3·994, and, agreeably with the results of his analysis (employing the ammonium chromate method for the separation of the alkaline earths), the following composition (after drying at 100° C.—Hygroscopic water = 0·06 per cent)—

Sulphur trioxide	42·09
Strontia	48·30
Baryta	9·44
Lime	trace.
	99·83

Allowing for an evidently slight deficiency in the amount of sulphur trioxide found, the constitution of the mineral may be thus represented :—

Strontium sulphate	85·63
Barium sulphate	14·38
Calcium sulphate	trace.
	100·01

2. Hübnerite.

This mineral has been met with, in situ, at Emerald, on Tom Murphy's Brook—a small stream about midway between Pine and Coady brooks, and all flowing into Big Brook—about nine miles, by road, from Margaree Forks, Inverness county, in the province of Nova Scotia. It was here found, associated with small quantities of chalcopyrite and a very little pale yellow hydrous mica, irregularly distributed through a mass of light grayish-white, translucent quartz, weighing about a ton and a half, found lying at the outcrop of a lenticular vein of a similar quartz, of some two feet and a half to three feet in width, cutting a gneissic or granitic rock of Pre-Cambrian age. The detached quartz mass afforded, it has been variously estimated, from three hundred to five hundred pounds of dressed material. The vein, however, contained but a comparatively small scattering of the mineral, and that only for about a couple of feet in.

It occurs in the quartz in the form of narrow seams and small irregular masses having a coarsely laminated structure; has a brownish-black colour, a submetallic lustre, breaks with a small subconchoidal fracture and affords a brownish-yellow streak. Mr. R. A. A. Johnston found it to have a specific gravity, at 15·5°C., of 6·975, and, conformably with the results of his analysis—conducted upon carefully selected material—the undermentioned composition :—

Tungsten trioxide	74·28
Molybdenum trioxide	trace.
Manganous oxide	22·73
Ferrous oxide	0·47
Lime	0·02
Magnesia	0·86
Silica	1·33
	99·69

3. Hydromagnesite.

This species, now for the first time identified as occurring in Canada, has been met with in considerable abundance in the immediate vicinity of the 108-mile House on the Cariboo road, ninety-three miles north of Ashcroft, Lillooet district, in the province of British Columbia, where it forms three or four deposits of from fifty to one hundred feet across, standing a foot or more above the level of the surrounding surface, and is also traceable from the one to the other of these deposits over an area of probably fifty or more acres of ground. A shaft sunk on one of these deposits passed through—first, close upon five feet of the pure white material; then, a layer of about six inches of the same of a somewhat yellowish colour; then, another layer of some three feet of the pure white material; then, another layer of

about eighteen inches of the yellowish coloured material ; then, another, apparently thin, layer of the pure white material ; finally reaching, what evidently constitutes the bed of the deposit, a dark coloured mud containing a few more or less well preserved shells. On another of these deposits, a shaft was carried, it is said, to a depth of thirty feet without the bottom being reached.

The material examined consisted of a pure white, more or less firmly compacted, yet readily friable, aggregate of very fine crystalline particles with a few delicate, intermingled rootlets. Its analysis afforded Mr. R. A. A. Johnston the following results :—

Carbon dioxide	37·03
Magnesia	43·71
Lime	0·10
Alumina	0·02
Ferric oxide	0·04
Phosphorus pentoxide	0·30
Silica, soluble	0·38
Water, with a little organic matter	17·79
Insoluble residue	1·53
	100·90

The insoluble residue consisted of :

Silica	1·35
Alumina	0·10
Ferric oxide	0·03
Lime	0·03
Magnesia	0·02
	1·53

The origin of these deposits of hydromagnesite may, it is conjectured, be connected with the occurrence of the later Tertiary volcanic rocks—basalts, et cetera, which, according to Dr. G. M. Dawson, are abundantly represented in the area of country above referred to.

Another series of some three or more deposits of hydromagnesite has more recently been discovered by Mr. J. C. Gwillim some 675 miles north-west of the above-mentioned locality, in a depression running north-west for about a mile back of Atlin City townsite, on the east side of Atlin Lake, in Cassiar district. Of these deposits, one, the largest, has an area of some two acres and a-half, and two have an area of about one acre, whilst the others are less extensive. As in the case of those above described, they present the appearance of raised deposits, their surfaces being two to three feet above the level of the swamp-muck or mud flat in which they lie. Nothing has been done towards ascertaining the thickness of these deposits beyond the sinking, in one instance, of a pit to the depth of five feet just outside the edge of one of the one-acre deposits, and this, as far as it went, passed only through a pure white hydromagnesite. Large exposures of

a more or less pure magnesite rock, as also of serpentinized rocks occur, it may be observed, in the immediate vicinity of thess deposits.

4. Natron.

A very considerable deposit of natron, a mineral not previously recognised as occurring in Canada, has been met with in Goodenough Lake, about twenty-eight miles due north of Clinton, Lillooet district, in the province of British Columbia. The deposit, at the time of its examination—the close of the dry season—was found to cover the whole of the bottom of the lake, which has an area of not less than twenty acres, up to within eight or ten feet of its margin, and to have a fairly uniform thickness of from seven and a half to eight and a half inches, but to thin down at the edge to about two inches. It was covered by about three inches of water, but in the spring and early summer, after the melting of the snow, this is said to be increased to a depth of some three feet, more or less. The deposit would, it has been estimated, represent, approximately, twenty thousand tons of material. Natural soda also occurs in Last Chance Lake, a sheet of water some eight miles distant, in a north-east direction, from Goodenough Lake, but in this instance the soda, at present, only forms small detached masses on certain parts of the bottom of the lake, although the Indians residing in this locality state that the deposit at one time covered the entire bed of the lake to a depth, of at least, six inches. There are other shallow lakes, not far removed from these, in this section of the country, which have not, as yet, been examined, but which may not improbably also prove to be of the same character as those above referred to.

The specimen examined, a large cake of the material of close upon seven inches in thickness, was translucent and perfectly colourless, save and excepting at and a little above where it had been in contact with the clayey stratum upon which it had formed, and here it exhibited a faint greenish-white colouration. Its analysis afforded Mr. R. A. A. Johnston as follows :—

Soda	21·36
Ammonia, very small quantity	undet.
Sulphur trioxide	0·08
Phosphorus pentoxide	0·01
Boron trioxide	trace.
Carbon dioxide, expelled on ignition	0·29
Carbon dioxide, in ignited residue	15·17
Chlorine	0·01
Silica	0·01
Water (direct estimation)	63·03
	99·96

Corresponding to,—the silica being disregarded :

Sodium carbonate	35·54
Sodium bicarbonate	1·34
Sodium sulphate	0·14
Sodium chloride	0·02
Sodium metaborate	trace.
Sodium-hydrogen-ammonium phosphate	0·02
Water	62·89
	99·95

The mud, referred to above as the clayey stratum upon which the natron deposited rested, was of a dark greenish-gray colour, but on exposure to the light speedily assumed paler shades, and ultimately became light greenish-gray. Through it were distributed numerous fine grains and coarse rounded particles and fragments of colourless transparent natron. Its examination, by Mr. F. G. Wait, showed it to have, approximately, the following composition :—Water, at 100°C 42·0 ; salts removable by water, 17·0 ; salts removable by hydrochloric acid, 20·0 ; argillaceous matter with a little grit, 21·0=100·0. The portion soluble in water, contained a large quantity of soda, small quantities of potassa, lime and magnesia, and traces of alumina and ferrous oxide, together with a large quantity of carbonic acid, a somewhat large quantity of chlorine, and very small quantities of sulphuric and phosphoric acids, and a trace of silica. The chief constituent removed by water evidently being carbonate of soda. The portion removed by the after treatment with hydrochloric acid, contained a large quantity of ferrous oxide, somewhat large quantities of lime and magnesia, and a small quantity of alumina, together with a rather large quantity of carbonic acid, and a small quantity of sulphuric acid and of silica. The residue left after treatment with water and acid, proved to be a highly plastic clay, containing a large proportion of exceedingly fine scaly kaolinite, through which was disseminated small quantities of grit consisting, for the most part, of minute grains of translucent quartz, with some few others of felspar, a few equally minute crystals of hornblende, and a few scales of mica.

The analysis of the water of the lake in which this natron deposit occurs, is given beyond.—page 48.

These soda lakes, which are situate, approximately, some twenty-two miles south-south-west of the site of the hydromagnesite locality, referred to on a previous page, occupy, it may be mentioned, according to Dr. G. M. Dawson, shallow depressions in the later Tertiary basaltic plateau of this part of the interior of British Columbia.

5. Polycrase.

Fine examples, of what on examination by Mr. R. A. A. Johnston proved to be polycrase—a mineral not previously identified as occurring in Canada, have been found by Mr. C. W. Willimott, on the nineteenth lot of the ninth concession of the township of Calvin, district of Nipissing, in the province of Ontario, where it occurs in the form of crystalline masses—one of which weighed rather more than seven hundred grams—associated with xenotime, a highly altered, cleavable massive form of magnetite, and small quantities of a brownish-red spessartite, in a coarse granite vein of some twenty feet in width, composed of quartz, microcline, albite or oligoclase, muscovite and biotite, which is there found cutting a reddish, fine grained, hornblendic gneiss.

The mineral has a pitch-black colour; an uneven, in parts subconchoidal fracture; a resinous lustre; is brittle; and affords a grayish-brown streak. Its specific gravity, at 15·5°C., is 4·842.

A very carefully conducted qualitative analysis showed it to contain—Niobic oxide, large amount; tantalic oxide, somewhat small amount; titanic oxide, large amount; yttrium oxide, somewhat small amount; thorium oxide, small amount; stannic oxide, trace; cerous oxide, small amount; lanthanum oxide, small amount; didymium oxide, small amount; uranous oxide, small amount; ferrous oxide, small amount; magnesia, trace; water, very small amount. Zirconia was sought for, and found to be absent.

MINERALOGICAL NOTES.

1.—Arsenic, Native.—A fine-granular massive variety of this mineral occurs, as first observed by Mr. R. W. Brock, in reniform nodules, with arsenopyrite, pyrrhotite, pyrite, et cetera, in veins of calcite traversing a more or less quartzose gneiss, or mica-schist, at the L. H. gold claim, on Eight-mile Creek, east side of Slocan Lake, in the West Kootenay district of the province of British Columbia.

2.—Beryl. Large, but for the most part very imperfect, crystals of a yellow variety of this mineral have been found by Mr. C. W. Willimott, associated with black tourmaline and spessartite, in a coarse granite vein on the thirteenth lot of the fourth concession of the township of Calvin, in the district of Nipissing, province of Ontario. One of the finest specimens obtained from this vein

is in the form of a rough hexagonal prism measuring six by six and a-half centimetres in its diameters, consisting of a slightly altered beryl of a straw-yellow, in parts honey-yellow, colour, subtranslucent, and having a waxy lustre, in large part replaced by a light, at times somewhat dark, grayish-white quartz.

3.—Calcite. Large cleavable masses of a colourless, transparent,—in parts pale purplish and semi-transparent, calcite have been met with by Mr. C. W. Willimott, in a white, moderately coarse to coarse crystalline, more or less graphitic, limestone, occurring on the sixth lot of the second concession of the township of March, Carleton county, in the province of Ontario. This calcite, in many instances, exhibits twinning in a direction paralled with that of the basal plane and which, by frequent repetition, occasionally gives a laminated appearance to the mineral.

4.—Fuchsite. A bright apple-green to emerald-green chromiferous muscovite, which has been identified by Mr. R. A. A. Johnston, as fuchsite, occurs in the form of fine scaley aggregations, with small particles and masses of chromite, and grains and small irregular veins of colourless translucent quartz, distributed through a granular massive magnesite which is found in the first range of mountains on the east side of Big Salmon River, a tributary of the Lewes, just below Island Lake, in the Yukon district, North-west Territory. This variety of muscovite has also been recognized as occurring in the form of fine scales, disseminated through a massive magnesite which is found some three hundred miles north-west of the last mentioned locality, on the east side of the Yukon, about a mile and a-half above Indian River; and in a north-easterly direction from this again, it occurs, in similar fine scales, scattered through a white dolomite which is met with about a mile and a-half above the mouth of Hunker Creek, a tributary of the Klondike River—also in the Yukon district.

5.—Jamesonite. A steel-gray fibrous massive form of this mineral occurs, associated with pyrite and pyrrhotite, in a gangue of grayish-white crystalline dolomite, on the thirtieth lot of the second concession of the township of Clarendon, Frontenac county, in the province of Ontario.

6.—Magnesite. This mineral has been met with, by Mr. R. G. McConnell, in very considerable abundance, in the first range of mountains on the east side of Big Salmon River, a tributary of the Lewes, just below Island Lake, in the Yukon district,

North-west Territory, where it occurs in the form of heavy bands —which are, in some instances, in parts, fifty feet or more in thickness—associated with dark and light coloured, partly altered, slates, greenish schists, and serpentine. The rock, which is strongly coherent, is made up of brilliant cleavable grains of a grayish-white, at times almost colourless, ferruginous magnesite, and through it irregularly distributed, occur fine scaly aggregations of a bright apple-green to emerald-green chromiferous muscovite—fuchsite, small particles and masses of chromite, and grains and small irregular veins of colourless translucent quartz. A very similar magnesite rock has also been found by Mr. McConnell, in the same district, associated with rocks of much the same character as those above referred to, some three hundred miles north-west of the foregoing locality, on the east side of the Yukon, about a mile and a-half above Indian River.

7.—Marl. A sample of a very pure, light grayish—when air-dried, shell marl has been received from Mr. J. Obalski, which occurs in some quantity at Lac à la Peinture, in the township of Neigette, Rimouski county, in the province of Quebec.

8.—Rutile. A prismatic and massive form of black rutile—possibly referable to nigrine or ilmenorutile—has been identified by Mr. R. A. A. Johnston, in some samples of auriferous quartz veinstone, collected by Mr. E. R. Faribault, from the Irving vein or lead, in the Mooseland gold district, Halifax county, in the province of Nova Scotia.

9.—Stibnite. Has been met with in the form of fine granular and radiating columnar masses, distributed through a gangue of white cryptocrystalline quartz, at the Mountain Chief claim, on Cadwallader Creek, a stream flowing into Upper Bridge River, Lillooet district, in the province of British Columbia.

10.—Thinolite. Among other specimens collected by the Count de Sainville in the course of his exploration—1889-94, of the delta of the Mackenzie River, North-west Territory, was one found by him, immediately west of the delta, in a disintegrated clay shale of Cretaceous age. It consists of a stellar aggregate of more or less acute, quadrilateral, pyramidal forms of a pseudomorphous calcium carbonate of some six centimetres across, exteriorly of a dark brown colour and dull earthy lustre, but interiorly of a yellowish-brown colour, a vitreous lustre, and exhibiting a very finely crystalline structure.

11.—Titanite. Remarkably fine large lustrous contact-twins of black titanite, have been found by Mr. C. W. Willimott, in a vein composed of orthoclase, scapolite, pyroxene, and calcite, with some quartz and mica, cutting granite on the twenty-first lot of the eleventh range of the township of Litchfield, Pontiac county, in the province of Quebec.

12.—Tufa, Calcareous. This substance has been met with, constituting what is apparently a large deposit, on the southern slope of Connaught Mountain, about eleven miles north-east of the head of Okanagan Lake, district of Yale, in the province of British Columbia.

13.—Vivianite. Some very good specimens, of what on examination proved to be an earthy form of this mineral, have been received from Mr. John Blue, Superintendent of the Eustis Mining Company, with the information that the same had been met with, in a bed of laminated clay, some three or four feet or more beneath a gravelly soil, in sinking a pit on the left bank of the Massawippi River, on the twenty-fifth lot of the second range of the township of Hatley, Stanstead county, in the province of Quebec. The mineral has also been observed in other places, not far from the one in question, in an extension of the same deposit of clay, both on this and the right bank of the river. The hydrous ferrous phosphate, which is unevenly distributed through the clay, is, when first taken out, perfectly white, but on exposure to the atmosphere rapidly assumes a fine bright blue colour.

ROCKS.

1.—A fine-crystalline bluish-gray schist. From Sawmill Bay, Pilot Bay village, east side of Kootenay Lake, West Kootenay district, province of British Columbia. Collected by Mr. R. G. McConnell, September 7, 1897.

Its analysis afforded Mr. R. A. A. Johnston, the following results :—

Silica	69·50
Alumina	15·05
Ferric oxide	0·27
Ferrous oxide	2·38
Manganous oxide	trace.
Lime	1·10
Magnesia	3·20
Potassa	4·75
Soda	2·85
Water (direct estimation)	0·50
	99·60

The specific gravity, at 15·5°C., was found to be 2·693.

LIMESTONES.

(Continued from page 21 R. of the last Annual Report of this Survey—vol. ix., 1896.)

1.—From McLean's quarry, Lime Brook, Springville, Pictou county, province of Nova Scotia. Geological position—Lower Carboniferous. Collected by Dr. H. M. Ami, 1896.

A faint purplish-gray, compact, massive limestone. Its analysis afforded Mr. Wait the following results:

(After drying at 100° C.—Hygroscopic water = 0·08 per cent.)

Carbonate of lime		97·04
" magnesia		1·09
" iron		0·26
" manganese		0·44
Sulphate of lime	0·03	
Alumina	0·19	
Silica, soluble	0·14	1·39
Insoluble mineral matter	1·01	
Organic matter	0·02	
		100·22

2.—From Mr. Robert Corkum's quarry at Goat Lake, township of Chester, Lunenburg county, province of Nova Scotia. Geological position—Lower Carboniferous. Collected by Mr. E. R. Faribault, 1896.

A light to dark-gray, compact, massive limestone, with occasional minute veinings and small inclusions of white crystalline calcite. An analysis, by Mr. Wait, showed it to have the following composition :

(After drying at 100° C.—Hygroscopic water=0·07 per cent.)

Carbonate of lime		97·03
" magnesia		0 92
" iron		0·58
" manganese		0·63
Sulphate of lime	0·07	
Alumina	0·34	
Silica, soluble	0·03	1·11
Insoluble mineral matter	0·53	
Organic matter	0·14	
		100·27

This stone has been wrought to a considerable extent, chiefly, if not solely, for the manufacture of lime.

3.—From Captain Edward Lordlay's quarry at Indian Point, township of Lunenburg, Lunenburg county, province of Nova Scotia. Geological position—Lower Carboniferous. Collected by Mr. E. R. Faribault, 1896.

A somewhat light-gray, compact, massive limestone with, here and there, small inclusions of white crystalline calcite. Its composition was found, by Mr. Wait, to be as follows :

(After drying at 100° C.—Hygroscopic water = 0·12 per cent.)

Carbonate of lime		97·21
" magnesia		0·55
" iron		0·48
" manganese		0·58
Sulphate of lime	0·07	
Alumina	0·41	
Silica, soluble	0·02	1·10
Insoluble mineral matter	0·49	
Organic matter	0·11	
		99·92

This stone is used for the manufacture of lime.

4.—From an outcrop on the south-western side of Hemlock Lake, township of Gloucester, Carleton county, province of Ontario. Geological position—Chazy formation, Cambro-Silurian. Examined for Mr. T. M. Clark.

A very fine grained and compact, greenish-gray,—yellowish-brown and reddish-brown weathering, massive limestone. An analysis by Mr. Johnston, showed it to have the following composition :

(After drying at 100° C.—Hygroscopic water = 0·98 per cent.)

Lime	19·78
Magnesia	10·55
Alumina	0·75
Ferric oxide	0·27
Ferrous oxide	1·71
Manganous oxide	0·38
Carbonic anhydride	26·03
Sulphuric anhydride	0·07
Phosphoric anhydride	0·14
Silica, soluble	0·60
Water	0·20
Insoluble mineral matter	38·81
	99·29

The insoluble mineral matter consisting of:

Silica	24·20
Alumina	6·77
Ferric oxide	3·23
Magnesia	1·47
Potassa	1·46
Soda	0·15
Water (ignition)	1·53
	38·81

The band from which this argillaceous magnesian limestone was taken, has been supposed to be an extension of the beds affording a cement-stone, which are worked by Mr. C. B. Wright on the thirty-fourth lot of the first concession, Ottawa Front, of Nepean township, in the above mentioned county of Carleton.

5.—From a quarry near Kananaskis station on the line of the Canadian Pacific Railway, north-east quarter of section 25, township 24, range 9, west of the fifth initial meridian, district of Alberta, North-west Territory. Received from Mr. William Pearce.

A light grayish, somewhat coarse crystalline, massive limestone. Its analysis afforded Mr. Wait, as follows:

(After drying at 100° C.—Hygroscopic water = 0·04 per cent.)

Carbonate of lime		98·27
" magnesia		1·11
" iron		0·05
Sulphate of lime	0·08	0·26
Alumina	0·09	
Silica, soluble	0·03	
Insoluble mineral matter	0·06	
		99·69

This stone is used for the manufacture of lime.

6.—From a quarry at the north end of Tunnel Mountain, district of Alberta, North-west Territory. Received from Mr. William Pearce.

A dark gray compact, massive limestone. An analysis by Mr. Wait, gave:

(After drying at 100° C.—Hygroscopic water = 0·04 per cent.)

Carbonate of lime		93·77
" magnesia		5·40
" iron		0·08
Sulphate of lime	0·07	1·33
Alumina	0·02	
Silica, soluble	0·03	
Insoluble mineral matter	1·05	
Organic matter	0·16	
		100·58

This stone is employed for the manufacture of lime.

The same band of limestone is found, to the north of the above mentioned locality, in Stony Squaw Mountain, and again, in Rundle Mountain—in the same district.

IRON ORES.

1.—Hematite. From near the mouth of Mabou Harbour, about half a mile to a mile inland, on the north side, Inverness county, province of Nova Scotia. Examined for Mr. John McKeen.

A massive red hematite, through which was distributed a few fragments of shells. Mr. Wait found it to contain:

Metallic iron	38·36	per cent.
Phosphorus	0·60	"
Insoluble matter	25·94	"

2.—Hematite. From the same locality as the preceding specimen.

A massive red hematite, with, here and there, a few embedded fragments of shells. Determinations by Mr. Wait gave:

Metallic iron	48·30	per cent.
Phosphorus	0·40	"
Insoluble matter	22·93	"

3.—Hematite. From the same locality as the two preceding specimens.

A massive red hematite, containing, in parts, a few embedded fragments of shells. A partial analysis by Mr. Wait showed it to contain:

Ferric oxide	59·51	per cent.
Manganous oxide	0·03	"
Phosphoric acid	1·28	"
Sulphur	trace.	
Insoluble matter	23·59	"
Metallic iron	41·66	"
Phosphorus	0·56	"

GOLD AND SILVER ASSAYS.

These were all conducted by Mr. R. A. A. Johnston.

As explanatory of the numerous instances in which no trace of either gold or silver was found, it may be mentioned that in nearly all these cases the assay was carried out by special request.

Province of Nova Scotia.

1.—From a vein on Corney Brook, about a mile and a half from its mouth, Inverness county. Examined for Mr. M. J. Doucet.

A coarse crystalline white calcite, carrying small quantities of galena. The latter, freed from all gangue, was found to contain:

Gold.............. none.
Silver.............. 5·833 ounces to the ton of 2,000 lbs.

2.—From near Whycocomagh, Inverness county.

An association of white crystalline limestone with a greenish-black chloritic mineral, carrying very small quantities of iron-pyrites.

It contained neither gold nor silver.

3.—This, and the three following specimens are from McPherson's farm, Whycocomagh, Inverness county. Examined for Mr. Charles McKay. A rust-stained quartzite. The sample, a single fragment, weighed four ounces.

It contained neither gold nor silver.

4.—A conglomerate, the component pebbles of which consisted, for the most part, of white quartz and reddish-white felspar. The sample, consisting of two fragments, weighed eleven ounces.

It contained neither gold nor silver.

5.—A greenish-gray serpentine limestone, carrying iron-pyrites. The sample, a single fragment, weighed one pound eight ounces.

It contained neither gold nor silver.

6.—A conglomerate, the component pebbles of which consisted, for the most part, of quartz and felspar. The sample, consisting of six fragments, weighed eleven ounces.

It contained neither gold nor silver.

7.—From Victoria county. This, and the following specimen, was examined for Mr. Charles Moffatt.

An association of white quartz with a brownish-black mica, carrying small quantities of copper-pyrites. Weight of sample, a single fragment, two ounces and a half. It was found to contain:

Gold.............. trace.
Silver.............. 0·175 of an ounce to the ton of 2,000 lbs.

8.—From the same locality as the preceding specimen.

A white subtranslucent quartz, carrying a few particles of iron-pyrites. Weight of sample, a single fragment, an ounce and a half.

It contained neither gold nor silver.

9.—This, and the two following specimens are from quartz veins traversing the rocks of the George River limestone, immediately north-west of George River, Cape Breton county. They were examined for Mr. Colin Chisholm.

A white subtranslucent quartz, carrying very small quantities of iron-pyrites, copper-pyrites, and galena. The sample, consisting of six fragments, weighed three pounds four ounces.

It contained neither gold nor silver.

10.—A grayish-white subtranslucent quartz, carrying very small quantities of iron-pyrites, copper-pyrites, and galena. The sample consisting of seven fragments, weighed one pound two ounces.

It contained neither gold nor silver.

11.—A white and reddish-white subtranslucent quartz, carrying small quantities of iron-pyrites and copper-pyrites. The sample, consisting of ten fragments, weighed one pound six ounces.

It contained neither gold nor silver.

12.—From Bryden's Mill, right bank of Bryden's Mill Brook, Benacadie Glen, Cape Breton county. Examined for D. J. McKinnon.

An association of a white subtranslucent quartz with a little greenish-gray felspathic rock, holding a few particles of iron-pyrites. Weight of sample, consisting of seven fragments, one pound two ounces.

It contained neither gold nor silver.

13.—From a vein at Barasois River, about two miles north of the Barasois bridge, Englishtown, Victoria county. Examined for Mr. J. E. Burchell.

A white subtranslucent quartz, carrying small quantities of copper-pyrites and a very little iron-pyrites. The sample, consisting of ten fragments—all of which were more or less stained with hydrated peroxide of iron and green carbonate of copper weighed three pounds five ounces. Assays gave :

Gold.............1·517 ounces to the ton of 2,000 lbs.
Silver.................2·275 " "

14.—From the Rev. Mr. Sinclair's place, Loch Lomond, Richmond county. A white subtranslucent quartz, carrying small quantities of galena and copper-pyrites. The sample, consisting of several fragments, weighed seventeen pounds. Assays showed it to contain :

Gold ....none.
Silver.....................1·225 ounce to the ton of 2,000 lbs.

Determinations of the lead and copper in this ore gave :

Lead	9·43 per cent
Copper	2·03 "

15.—From Cross Island, at the entrance to Lunenburg Harbour, Lunenburg county. Examined for Mr. J. W. King.

An association of white subtransculent quartz with a yellowish-white felspar, small quantities of gray chloritic schist, and a very little calcite, carrying very small quantities of pyrrhotite and iron-pyrites. The sample, consisting of numerous fragments, weighed four pounds ten ounces.

It contained neither gold nor silver.

16.—This, and the following specimen, is from the LaHave River, above Bridgewater, Lunenburg county.

Specimen collected above mill. A weathered conglomerate in which the component pebbles consisted, for the most part, of a greenish-white chloritic schist. Weight of sample, twenty-five pounds.

It contained neither gold nor silver.

17.—Specimen collected below mill. A weathered conglomerate, the component pebbles of which consisted, for the most part, of a greenish-white chloritic schist and a grayish-white felspar. Weight of sample, twenty-nine pounds.

It contained neither gold nor silver.

18.—This, and the three following specimens are from a locality in Digby county.

A white, more or less rust-stained, subtranslucent quartz, carrying small quantities of iron-pyrites and brownish-black zinc-blende. Weight of sample, six ounces.

It contained neither gold nor silver.

19.—A white subtranslucent quartz, carrying iron-pyrites. Weight of sample, twelve ounces.

It contained neither gold nor silver.

20.—A white crystalline quartz, carrying iron-pyrites and copper-pyrites. Weight of sample, five ounces.

It contained neither gold nor silver.

21.—A white subtranslucent quartz, carrying very small quantities of iron-pyrites. Weight of sample, six ounces.

It contained neither gold nor silver.

Province of New Brunswick.

22.—From Turtle Creek, Albert county. Examined for Prof. L. W. Bailey.

A grayish-white quartz conglomerate, carrying small quantities of iron-pyrites. Weight of sample, two pounds six ounces.

It contained neither gold nor silver.

Province of Quebec.

23.—From a large quartz vein at Upper Island Portage, Mekiskun or Bell River. This, and the seven following specimens were collected by Dr. R. Bell.

A white to grayish-white subtranslucent quartz, in parts coated with hydrated peroxide of iron, carrying very small quantities of iron-pyrites and copper-pyrites. Weight of sample, ten fragments, two pounds.

It contained neither gold nor silver.

24.—From a slaty quartz vein at the south-west end of Shagamog Bay, opposite the 'Wigwam,' Shabogama Lake, Mekiskun or Bell River.

It contained neither gold nor silver.

25.—From first portage below Shabogama Lake.

A white subtranslucent quartz with which was associated a little dark gray felspathic rock. Weight of sample, four ounces.

It contained neither gold nor silver.

26.—From outlet of Lake Olga.

An association of white translucent quartz with a little white granular pyroxene. The specimen, which was thickly coated with hydrated peroxide of iron, weighed one pound six ounces.

It contained neither gold nor silver.

27.—Also from the outlet of Lake Olga.

The material consisted of broken down siliceous rock matter. Weight of sample, one pound.

It contained neither gold nor silver.

28.—From a vein nearly mid-way between Long Lake and Big Lake, Broadback River.

A grayish-white subtranslucent quartz with a very little white calcite and a few scales of silver-white mica. Weight of sample, four ounces.

It contained neither gold nor silver.

29.—From another vein mid-way between Long Lake and Big Lake, Broadback River.

A grayish-white subtranslucent quartz through which was disseminated a few particles of iron-pyrites. Weight of specimen, five ounces.

It contained neither gold nor silver.

30.—Also from about mid-way between Long Lake and Big Lake, Broadback River.

A green chromiferous mica-schist, carrying a somewhat large quantity of iron-pyrites. Weight of sample, two fragments, eight ounces.

It contained neither gold nor silver.

31.—From a small shaft sunk on the fifth lot of the second range of the township of Calumet, Pontiac county. Collected by Mr. C. W. Willimott.

An association of white translucent quartz, a white triclinic felspar, a reddish granitic rock, and small quantities of white calcite and black augite, carrying some iron-pyrites and copper-pyrites. Weight of sample, nine ounces.

It contained neither gold nor silver.

32.—From lots two and three of the seventh range of the township of Calumet, Pontiac county. Collected by Mr. C. W. Willimott.

A gray quartzo-felspathic rock, carrying small quantities of iron-pyrites. Weight of sample, twelve ounces.

It contained neither gold nor silver.

North-east Territory.

33.—From Kan-uk-took-ya-so, Baffinland. This, and the three following specimens were collected by Dr. Bell :—

A white translucent quartz with which was associated a little reddish-gray felspar. The sample, a single fragment, weighed one pound three ounces.

It contained neither gold nor silver.

34.—From the same locality as the preceding specimen.

A gray subtranslucent quartz, carrying a very little iron-pyrites. The sample, a single fragment, weighed five ounces.

It contained neither gold nor silver.

35.—From the long vein in White Bluff Harbour, Baffinland.

An association of gray translucent quartz with a yellowish-gray felspar. Weight of sample, a single fragment, seven ounces.

It contained neither gold nor silver.

36.—Also from the long vein in White Bluff Harbour, Baffinland.

A coarse gray granite. The sample, a single fragment, weighed eleven ounces.

It contained neither gold nor silver.

Province of Ontario.

37.—From the thirtieth lot of the second concession of the township of Clarendon, Frontenac county. Examined for Mr. John Dack.

An association of jamesonite, iron-pyrites, and pyrrhotite, in a gangue of grayish-white crystalline dolomite. The sample, consisting of numerous small fragments, weighed six ounces. It was found to contain :

Gold..................trace.
Silver................2·800 ounces to the ton of 2,000 lbs.

38.—From what is known as the Caldwell pyrite deposit, east-half of lot eighteen, concession three, of the township of Dalhousie, Lanark county.

An association of white translucent quartz with a little grayish-white hornblende, carrying large quantities of iron-pyrites and pyrrhotite. Weight of sample, a single fragment, six pounds.

It contained neither gold nor silver.

39.—From the thirty-first lot of the sixth concession of the township of Cashel, Hastings county. Collected by Mr. A. E. Barlow.

An association of white subtranslucent quartz with small quantities of dark brown tourmaline. The sample, consisting of several fragments, weighed one pound fourteen ounces.

It contained neither gold nor silver.

40.—From the Higman mine, lot nine, concession seven, of the township of Limerick, Hastings county. Collected by Mr. A. E. Barlow.

A white translucent quartz, through which was scattered a few scales of white mica and particles of iron-pyrites. Assays gave :—

Gold..............none.
Silver............0·175 of an ounce to the ton of 2,000 lbs.

41.—From the south-half of the thirty-fourth lot of the seventeenth concession of the township of Monmouth, Haliburton county. This, and the following seven specimens are examined for Mr. A. D. Miller.

A massive iron-pyrites. The sample, two fragments, weighed one pound five ounces.

It contained neither gold nor silver.

42.—From the twenty-eighth lot of the seventeenth concession of the township of Monmouth, Haliburton county.

A white subtranslucent quartz, in parts coated with hydrated peroxide of iron, carrying some iron-pyrites and pyrrhotite. The sample, consisting of several fragments, weighed ten ounces.

It contained neither gold nor silver.

43.—From the same locality as the preceding specimen.

A white translucent quartz, for the most part coated with hydrated peroxide of iron, carrying small quantities of pyrrhotite and iron-pyrites. The sample, a single fragment, weighed nine ounces.

It contained neither gold nor silver.

44.—From the thirty-second lot of the seventeenth concession of the township of Monmouth, Haliburton county.

An association of white translucent quartz, in parts coated with hydrated peroxide of iron, with a little flesh coloured felspar. Weight of sample, a single fragment, six ounces.

It contained neither gold nor silver.

45.—From the thirty-third lot of the seventeenth concession of the township of Monmouth, Haliburton county.

A gray gneissoid-rock, in parts coated with hydrated peroxide of iron, through which was disseminated small quantities of iron-pyrites. The sample, a single fragment, weighed eight ounces.

It contained neither gold nor silver.

46.—From the same locality as No. 42, above.

A white and greenish-white pyroxene with a very little garnet and a few scales of mica, carrying very small quantities of pyrrhotite and iron-pyrites. The sample, two fragments, weighed seven ounces.

It contained neither gold nor silver.

47.—Also from the same locality as No. 42, above.

A gray gneissoid rock, containing small quantities of iron-pyrites. The sample, consisting of two fragments, weighed six ounces.

It contained neither gold nor silver.

48.—From the thirtieth lot of the sixteenth concession of the township of Monmouth, Haliburton county.

A white and reddish-white cleavable calcite with a few crystals of brown mica and small quantities of pyrrhotite. Weight of sample, two ounces and a half.

It contained neither gold nor silver.

49.—From Kamisho's mine, Michipicoten district. This, and the nineteen following specimens were collected by Dr. R. Bell.

A granular quartzite, through which was distributed small quantities of pyrrhotite and magnetite. The sample, a single fragment, weighed ten ounces. It was found to contain :

Gold..............0·233 of an ounce to the ton of 2,000 lbs
Silver.............none.

50.—From the Jubilee mine, Michipicoten district.

An association of white translucent quartz with small quantities of green chloritic schist and white calcite, carrying small quantities of iron-pyrites, The sample, consisting of two fragments, weighed one pound eight ounces.

It contained neither gold or silver.

51.—From the east pit, Diamond Jubilee mine, Michipicoten district.

An association of white quartz with a little gray felspathic rock, holding a few disseminated particles of pyrrhotite. The sample, consisting of three fragments, weighed two pounds one ounce.

It contained neither gold or silver.

52.—From the west pit, Diamond Jubilee mine, Michipicoten district.

A white translucent quartz, holding small quantities of pyrrhotite. The sample, a single fragment, weighed one pound three ounces.

It contained neither gold or silver.

53.—From the fourth pit, Diamond Jubilee mine, Michipicoten district.

A white cryptocrystalline quartz, in parts stained with hydrated peroxide of iron, carrying small quantities of iron-pyrites. The sample, consisting of four fragments, weighed seven ounces. Assays showed it to contain :

Gold..trace.
Silver..none.

54.—Material taken from vein at mouth of shaft, Jubilee mine, Michipicoten district.

An association of grayish-white subtranslucent quartz with a very little black tourmaline, in parts coated with hydrated peroxide of iron, through which was disseminated a few particles of iron-pyrites. The sample, consisting of ten fragments, weighed three pounds fourteen ounces. It was found to contain :

Gold.............0·875 of an ounce to the ton of 2,000 lbs.
Silver.............none.

55.—Material from each of the four pits on main vein, Diamond Jubilee mine, Michipicoten district.

A grayish-white subtranslucent quartz, in parts coated with hydrated peroxide of iron, through which was disseminated a few particles of iron-pyrites. The sample, consisting of four fragments, weighed three pounds three ounces. It contained :

Gold...trace.
Silver...none.

56.—From Wylie's mine, on Split-rock Portage, Magpie River, Michipicoten district.

A grayish to greenish-white translucent quartz, through which was distributed a few particles of iron-pyrites. The sample, a single fragment, weighed one pound four ounces.

It contained neither gold nor silver.

57.—From pit No. 1, Gananoque mine, Michipicoten district.

A white cryptocrystalline quartz, stained and coated with hydrated peroxide of iron. The sample, consisting of four fragments, weighed two pounds four ounces.

It contained neither gold nor silver.

58.—From pit No. 2, Gananoque mine, Michipicoten district.

A white cryptocrystalline quartz, in parts stained and coated with hydrated peroxide of iron, carrying small quantities of iron-pyrites. The sample, consisting of three fragments, weighed two pounds fifteen ounces.

It contained neither gold nor silver.

59.—From the Maud mine, Michipicoten district.

A grayish-white translucent quartz, stained and coated with hydrated peroxide of iron. The sample, a single fragment, weighed one pound fifteen ounces.

It contained neither gold nor silver.

60.—From the Aurora mine, Michipicoten district.

A white quartzite, stained and coated with hydrated peroxide of iron. The sample, a single fragment, weighed fifteen ounces.

It contained neither gold nor silver.

61.—From the Prescott mine, Michipicoten district.

A somewhat cavernous white translucent quartz, in parts coated with hydrated peroxide of iron. The sample, a single fragment, weighed ten ounces.

It contained neither gold nor silver.

62.—From Billings' prospect, on the new road near to Legg and Barton's shanty, Michipicoten district.

A decomposed vein matter, consisting of a white granular quartz stained with hydrated peroxide of iron. Weight of sample, one pound seven ounces.

It contained neither gold nor silver.

63.—From the Frechette mine, sixteen miles east-north-east of Gargantua Harbour, Michipicoten district.

A grayish-white translucent quartz, more or less coated with hydrated peroxide of iron, carrying small quantities of copper-pyrites. The sample, a single fragment, weighed twelve ounces. It was found to contain :

Gold................trace.
Silver................0·117 of an ounce to the ton of 2,000 lbs.

64.—From the east pit, Ward's mine, Michipicoten district.

An association of white subtranslucent quartz with a little green chloritic schist, in parts coated with hydrated peroxide of iron. The sample, consisting of two fragments, weighed one pound one ounce.

It contained neither gold nor silver.

65.—From the north vein, Mackie's mine, Lake Wawa, Michipicoten district.

An association of white translucent quartz with a very little black tourmaline, in parts coated with hydrated peroxide of iron, carrying small quantities of pyrrhotite. The sample, consisting of three fragments, weighed two pounds eleven ounces. Assays gave :

Gold..trace.
Silver..none.

66.—From the south vein, Mackie's mine, Lake Wawa, Michipicoten district.

An association of white subtranslucent quartz with a little black tourmaline, carrying small quantities of pyrrhotite. The sample, a single fragment, weighed one pound five ounces. Assays showed it to contain :

Gold.................. 0·175 of an ounce to the ton of 2,000 lbs.
Silver.................none.

67.—From a large quartz vein at the mouth of White Lake Creek, White River, Mississagi region.

A white translucent quartz, coated with hydrated peroxide of iron, through which was distributed a few particles of copper-pyrites. The sample, a single fragment, weighed fifteen ounces.

It contained neither gold nor silver.

68.—From near bridge across White River, Mississagi region.

A grayish-white quartzite, coated with hydrated peroxide of iron, carrying small quantities of copper-pyrites, pyrrhotite and specular iron. The sample, consisting of three fragments, weighed one pound three ounces.

It contained neither gold nor silver.

69.—From location L., south of Ignace, district of Rainy River. Collected by Mr. W. McInnes.

A gray subtranslucent quartz, carrying large quantities of iron-pyrites. The sample, consisting of two fragments, weighed one pound fourteen ounces.

It contained neither gold nor silver.

70.—From a large vein three miles east and just south of Taché station, on the line of the Canadian Pacific Railway. Collected by Mr. W. McInnes.

A white translucent quartz, stained with hydrated peroxide of iron, through which was distributed a few particles of pyrrhotite. The sample, consisting of numerous fragments, weighed four ounces.

It contained neither gold nor silver.

North-west Territory.

71.—From between Fort Resolution and Fort Rae, about forty miles from Fort Resolution, south side of Great Slave Lake. Examined for Mr. E. Lyon.

An association of gray mica-schist with a white subtranslucent quartz, more or less thickly coated with hydrated peroxide of iron, carrying some coarsely crystalline galena. Weight of sample, a single fragment, half an ounce. It was found to contain. :

Gold..................none.
Silver.................16·012 ounces to the ton of 2,000 lbs.

The galena amounted to 41·2 per cent, by weight, of the whole; hence, the same, freed from all gangue, would contain at the rate of 38·865 ounces of silver per ton of 2,000 lbs.

72.—From claim No. 10, one of a series of claims within a radius of ten miles of the mouth of Yellow Knife River, north side of Great Slave Lake. This, and the following specimen were examined for Mr. E. A. Blakeney.

A white subtranslucent quartz, in parts coated with hydrated peroxide of iron. The sample, a single fragment, weighed five ounces.

It contained neither gold nor silver.

73.—From claim No. 12, one of a series of claims within a radius of ten miles of the mouth of Yellow Knife River, north side of Great Slave Lake.

The material, which was said to have been taken from the above claim at a depth of fourteen feet, consisted of a weathered crystalline dolomite, carrying some iron-pyrites and a very little brown zinc-blende. The sample, consisting of several fragments, weighed five ounces. It was found, on assay, to contain :

Gold..................2·158 ounces to the ton of 2,000 lbs.
Silver.................0·408 of an ounce " "

74.—From between the head-waters of Cascade and Johnson Creeks, Rocky Mountains, district of Alberta. Examined for Mr. James Walker.

A finely crystalline, reddish-gray dolomite, carrying large quantities of copper-glance. The sample, consisting of two fragments, weighed one pound one ounce. It contained :

Gold.................trace.
Silver.................0·583 of an ounce to the ton of 2,000 lbs.

75.—From the east side of Big Salmon River, two miles below Island Lake, Yukon district. This, and the nine following specimens were collected by Mr. R. G. McConnell.

A white subtranslucent quartz, with which was associated small quantities of a green chromiferous mineral. The sample, a single fragment, weighed nine ounces.

It contained neither gold nor silver.

76.—From the east side of Big Salmon River, twenty-two miles below Island Lake, Yukon district.

A white subtranslucent quartz, stained and coated with hydrated peroxide of iron. The sample, a single fragment, weighed eight ounces.

It contained neither gold nor silver.

77.—From the west side of Big Salmon River, two miles above Island Lake, Yukon, district.

A white subtranslucent quartz. The sample, a single fragment, weighed seven ounces.

It contained neither gold nor silver.

78.—From the north side of Salmon River, one mile above the South Fork, Yukon district.

A grayish-white quartz porphyry. The sample, a single fragment, weighed seven ounces.

It contained neither gold nor silver.

79.—From Eldorado Creek, Klondike, Yukon district.

A light gray gneissoid rock. The sample, a single fragment, weighed eight ounces.

It contained neither gold nor silver.

80.—From Eldorado Creek, Klondike, Yukon district.

A white subtranslucent quartz, stained and coated with hydrated peroxide of iron. The sample, a single fragment, weighed eleven ounces. It was found to contain:

Gold............ trace.
Silver........... 0·117 of an ounce to the ton of 2,000 lbs.

81.—From near the Forks of Eldorado Creek, Klondike, Yukon district.

An association of white subtranslucent quartz with a little gray mica-schist. Weight of sample, a single fragment, four ounces.

It contained neither gold nor silver.

82.—From the mouth of Skookum gulch, Bonanza Creek, Klondike, Yukon district.

A light gray gneissoid rock. The sample, a single fragment, weighed seven ounces.

It contained neither gold nor silver.

83.—From about a mile and a half above the mouth of Hunker Creek, Klondike River, Yukon district.

An intermixture of white quartz and white dolomite with a little fine scaly fuchsite. The sample, a single fragment, weighed seven ounces.

It contained neither gold nor silver.

84.—From the east side of the Yukon, about a mile and a half above Indian River, Yukon district.

A slightly weathered magnesite through which was disseminated numerous fine scales of fuchsite. The sample, a single fragment, wieghed one pound nine ounces.

It contained neither gold nor silver.

85.—From mountains west of Henry House, Athabasca River. Collected by Mr. J. McEvoy.

A somewhat cavernous white translucent quartz, coated with hydrated peroxide of iron. The sample, consisting of two fragments, weighed one pound five ounces.

It contained neither gold nor silver.

Province of British Columbia.

Of the following—

Specimens Nos.	86-90	are from the	West Kootenay district
"	91-102	"	Interior plateau region.
"	103-106	"	Coast ranges and coast region.

86.—From the Lade claim, on Gainer Creek, fifteen miles from Trout Lake, West Kootenay district.

An association of white quartz and siderite, holding numerous small particles of native gold. The sample, a single fragment (most probably selected), weighed two ounces and a half. Assays gave :

Gold, at the rate of . .	174·341	ounces to the ton of	2,000 lbs.
Silver	15·021	"	"

87.—From the Fidelity claim, three miles from Silverton and a quarter of a mile from Slocan Lake, West Kootenay district.

A very finely crystalline galena. The sample, consisting of two fragments, weighed four ounces. It was found to contain :

Gold	trace.
Silver	220·208 ounces to the ton of 2,000 lbs.

88.—From the Dora Bromide claim, on Goat Mountain, about two miles from New Denver, West Kootenay district.

A reddish and grayish-white crystalline quartz, carrying small quantities of what appeared to be but galena. The sample, consisting of a single fragment, weighed eleven ounces. Assays showed it to contain :

Gold	0·350 of an ounce	to the ton of	2,000 lbs.
Silver	680·633 ounces	"	"

89.—From the Antelope mine, Slocan mining area, West Kootenay district. Collected by Mr. R. G. McConnell.

A gray calcareous felspathic rock, through which was disseminated numerous small crystals of iron pyrites. The sample, a single fragment, weighed four ounces. It contained:

Gold............ trace.
Silver........... 0·350 of an ounce to the ton of 2,000 lbs.

90.—From the Trail Creek mining area, West Kootenay district. Collected by Mr. R. G. McConnell.

A light gray brecciated granitic rock. The sample, a single fragment, weighed ten ounces.

It contained neither gold nor silver.

91.—From the Morning Star claim, near Spatsum, Interior plateau region. This, and the following specimen, was examined for Mr. John Blackhall.

A weathered schistose rock, coated with hydrated peroxide of iron and green carbonate of copper, carrying small quantities of iron-pyrites, copper-pyrites, and zinc-blende. The sample, consisting of numerous fragments, weighed eleven ounces. Assays gave:

Gold........... trace.
Silver........... 0·583 of an ounce to the ton of 2,000 lbs.

92.—From the same claim as the preceding specimen.

A weathered schistose quartzite, carrying small quantities of zinc-blende and copper-pyrites. The sample, consisting of several fragments, weighed twelve ounces. It contained:

Gold.............trace.
Silver.............0·233 of an ounce to the ton of 2,000 lbs.

93.—From Nine-mile Creek, Stikine River, Cassiar district, Interior plateau region. This, and the two following specimens were collected by Mr. R. G. McConnell.

A fine granular magnetite distributed through a silicious gangue-stone. The sample, a single fragment, weighed fourteen ounces.

It contained neither gold nor silver.

94.—From the same locality as the preceding specimen.

A reddish-gray granitic rock, in parts coated with green carbonate of copper, carrying some magnetite and a very little copper-pyrites. The sample, a single fragment, weighed thirteen ounces. It was found to contain:

Gold.............0·233 of an ounce to the ton of 2,000 lbs.
Silver.......... 0·817 " " "

95.—Also from the same locality as No. 93.

A granular magnetite distributed through a silicious gangue-stone. The sample, a single fragment, weighed nine ounces.

It contained neither gold nor silver.

96.—From the Blue Bird claim, about six miles north of Sicamous, Shuswap Lake, Interior plateau region.

An association of pyrrhotite, brown zinc-blende, and copper-pyrites in a gangue composed of white quartz, white calcite and a little black hornblende. The sample, consisting of four fragments, weighed four pounds. It contained :

Gold.... ....none.
Silver............0.117 of an ounce to the ton of 2,000 lbs.

97.—From the Bon Diable mine, Vernon, Interior plateau region.

An association of white translucent quartz with a dark gray chloritic schist, carrying iron-pyrites. The sample, consisting of six fragments, weighed two pounds eight ounces.

It contained neither gold nor silver.

98.—From the Blue Jay mine, one mile south-west of Swan Lake, near Vernon, Interior plateau region. Collected by Dr. G. M. Dawson.

The material, which represented the ordinary ore from tunnel and shaft, consisted of a dark gray to grayish-white quartz carrying small quantities of iron-pyrites. Assays showed it to contain :

Gold.............0·292 of an ounce to the ton of 2,000 lbs.
Silver..... .. ....1·750 ounces " "

99.—From Manson Creek, Shuswap Lake, Interior plateau region. Examined for Mr. Wentworth F. Wood.

A white subtranslucent quartz, in parts coated with hydrated peroxide of iron and green carbonate of copper, carrying small quantities of crystalline galena, copper-pyrites, and iron-pyrites. The sample, consisting of two fragments, weighed five ounces. It contained :

Gold........... 0·117 of an ounce to the ton of 2,000 lbs.
Silver..........305·958 ounces " "

100.—From mountains east of Tête Jaune Cache, Interior plateau region. This, and the following specimen, was collected by Mr. J. McEvoy.

A somewhat cavernous white subtranslucent quartz, in parts coated with hydrated peroxide of iron, carrying small quantities of coarsely crystalline galena. The sample, a single fragment, weighed six ounces. It was found to contain :

Gold.... .... .none.
Silver .... 0·350 of an ounce to the ton of 2,000 lbs.

101.—From the same locality as the preceding specimen.

A somewhat cavernous white subtranslucent quartz, coated with hydrated peroxide of iron. The sample, a single fragment, weighed five ounces.

It contained neither gold nor silver.

102.—From a point some forty-seven miles north-east of Kamloops, on the east side of the North Thompson River, and about seven miles back, Interior plateau region. Examined for Mr. Hugh McKinnon.

The material consisted of three distinct fragments—*a.*) consisting of a brownish-gray garnet rock, coated with hydrated peroxide of iron, carrying small quantities of copper-pyrites, and weighing seven ounces :—*b.*) consisting of an association of a white crystalline felspar with some white translucent quartz, coated with hydrated peroxide of iron, carrying small quantities of iron-pyrites, and a little copper-pyrites, and weighing eight ounces :—*c.*) consisting of an association of a brownish-gray garnet, white calcite, white granular felspar, and yellowish-green epidote, carrying small quantities of copper-pyrites and a few flakes of molybdenite, weighing nine ounces. A fair average of the whole was found, on assay, to contain :

Gold ....trace.
Silver...............3·792 ounces to the ton of 2,000 lbs.

103.—This, and the two following specimens are from a vein fifteen feet or more in width, some three or three and a half miles by trail from the head of Fanny Bay on Phillip's Arm, Coast ranges and coast region.

A white subtranslucent quartz, carrying small quantities of iron-pyrites. The sample, a single fragment, weighed twelve ounces. It was found to contain :

Gold.................1·806 ounces to the ton of 2,000 lbs.
Silver...............4·550 " "

104.—A white subtranslucent quartz, carrying small quantities of iron-pyrites. The sample, a single fragment, weighed five ounces. Assays showed it to contain :

Gold...........0·175 of an ounce to the ton of 2,000 lbs.
Silver..........0·350 " "

105.—A white subtranslucent quartz, carrying small quantities of iron-pyrites and brownish-black zinc-blende. The sample, consisting of two fragments, weighed one pound. It contained :

Gold.................2·742 ounces to the ton of 2,000 lbs.
Silver...............9·917 " "

106.—From the Two Sisters and Crow Claim, Deer Creek, Clayoquot, Coast ranges and coast region. Examined for Mr. F. Jacobsen.

An association of copper-pyrites and a little pyrrhotite, together with a small amount of quartzose gangue. The sample, consisting of two fragments, weighed one pound and two ounces. Assays gave :

Gold . ...none.
Silver.............0·817 of an ounce to the ton of 2,000 lbs.

NICKEL AND COBALT.

Estimation of, in certain ores from the undermentioned localities in the provinces of Quebec and British Columbia—Continued from p. 39 R of the Annual Report of this Survey (vol. ix.), for 1896.

1.—From the south-east half of the sixth lot of the second range of the township of Calumet (Calumet Island), Pontiac county, province of Quebec.

A quartz amphibolite, carrying a somewhat large quantity of pyrrhotite, some iron-pyrites, a small quantity of copper-pyrites and a very little zinc-blende. The pyrrhotite, freed from all gangue and associated minerals, was found by Mr. Wait to contain :

Nickel	1·48 per cent.
Cobalt	none.

2.—From the twelfth lot of the ninth range of the township of Calumet (Calumet Island), Pontiac county, province of Quebec. Examined for Mr. E. P. Cowen.

A compact, massive pyrrhotite, through which was disseminated small quantities of a quartzose gangue. An analysis by Mr. Wait showed it to contain :

Nickel	3·88 per cent.
Cobalt	0·32 "

The gangue constituted 4·30 per cent, by weight, of the whole The metalliferous portion of the ore contained, therefore, 4·06 per cent of nickel and 0·33 per cent of cobalt.

3.—From the fourteenth lot of the sixth range of the township of Aylwin, Ottawa county, province of Quebec. Examined for Mr. Robert Joynt.

The material consisted, in part, of a compact, massive pyrrhotite, almost free from foreign admixture ; and the balance of a similar pyrrhotite, distributed through a gangue composed of quartz with some felspar and mica and a little hornblende and calcite. The pyrrhotite, freed from all gangue, was found on analysis, by Mr. Wait, to contain :

Nickel..	1·68 per cent.
Cobalt..	none.

4.—From one of the Leviathan group of claims on Campbell Creek, east side of Kootenay Lake, West Kootenay district, province of British Columbia. Examined for Mr. F. W. Pettit.

An association of quartz with small quantities of felspar, hornblende and graphite, through which was distributed a small quantity of pyrrhotite and a very little copper-pyrites. Determinations by Mr. Wait gave :

Nickel..	0·06 per cent.
Cobalt..	none.

The gangue constituted 61·84 per cent, by weight, of the whole. The metalliferous portion of the ore contained, therefore, 0·16 per cent nickel.

5.—From the mineral claim R and K, situated on the range of mountains on the east side of Kootenay Lake, about a mile north of Argenta, West Kootenay district, province of British Columbia. Examined for Mr. J. Turner.

A massive pyrrhotite, in association with a very little copper-pyrites, through which was disseminated a trifling amount of gangue consisting of quartz with a very small quantity of felspar. Mr. Wait found it to contain :

Nickel..	0.05 per cent.
Cobalt..	none.

6.—From Kennedy Lake, west coast of Vancouver Island, province of British Columbia.

A massive pyrrhotite, through which was disseminated a few particles of copper-pyrites, and a small quantity of gangue composed, mainly, of garnet and calcite with a little quartz and hornblende. An analysis, by Mr. Wait, showed it to contain :

Nickel..	0·15 per cent.
Cobalt..	trace.

The gangue constituted 7·50 per cent, by weight, of the whole The metalliferous portion of the ore contained, therefore, 0·16 per cent nickel.

4.—From the Two Sisters and Crow claim, Deer Creek, Clayoquot, Vancouver Island, province of British Columbia. Examined for Mr. F. Jacobsen.

An association of copper-pyrites with some pyrrhotite and a small quantity of quartzose gangue. Determinations by Mr. Wait gave:

Nickel	0·69 per cent.
Cobalt	traces.

The pyrrhotite constituted, approximately, 41 per cent, by weight, of the whole, and contained, therefore, about 1·7 per cent of nickel.

NATURAL WATERS.

The analyses of these, were all conducted by Mr. F. G. Wait.

1.—Water from a well on the farm of Mr. W. J. O'Neill, lot fifteen, concession two, of the township of Fitzroy, Carleton county, province of Ontario. Mr. C. W. Willimott, who has visited the locality in question, informs me that the well has a diameter of eight feet, and a depth of ten : is sunk in a blue plastic clay, and that this alone has been encountered; further, that the flow of water is but feeble—not exceeding thirty-six gallons in about forty-eight hours.

The sample received for examination contained a little white, flocculent, organic matter in suspension,—this was removed by filtration. The filtered water was perfectly clear; had a faint brownish-yellow colour; was odourless; and tasted mildly saline. Reaction, neutral, both before and after concentration. Its specific gravity, at 15·5° C., was found to be 1010·48. Boiling produced a slight precipitate, consisting of carbonates of lime and magnesia, with a trace of ferric hydrate.

One thousand parts, by weight, of the filtered water, at 15·5° C., were found to contain :

Potassa	0·099
Soda	5·987
Lithia	trace.

Lime	0·344
Magnesia	0·753
Ferrous oxide	trace.
Sulphuric acid	0·291
Phosphoric acid	trace.
Boric acid	trace.
Carbonic acid	0·494
Chlorine	8·145
Bromine	trace.
Iodine	strong trace.
Silica	0·010
Organic matter	trace.
	16·123
Less oxygen, equivalent to chlorine	1·835
	14·288

The foregoing acids and bases may reasonably be assumed to be present in the water in the following state of combination :

The carbonates being calculated as mono-carbonates, and all the salts estimated as anhydrous.)

Chloride of potassium	0·157
" sodium	11·298
" lithium	trace.
" magnesium	1·624
Bromide of sodium	trace.
Iodide of sodium	trace.
Phosphate of soda	trace.
Biborate of soda	trace.
Sulphate of lime	0·495
Carbonate of lime	0·250
" magnesia	0·147
" iron	trace.
Silica	0·010
Organic matter	trace.
	13·981
Carbonic acid, half-combined	0·187
" free	0·120
	14·288

Total dissolved solid matter, by direct experiment, dried at 180° C., = 14·05.

An imperial gallon of the water, at 15·5° C., would contain :

(The carbonates being calculated as anhydrous bi-carbonates, and the salts without their water of crystallization.)

	Grains.
Chloride of potassium	11·105
" sodium	799·148
" lithium	trace.
" magnesium	114.871

Bromide of sodium	trace.
Iodide of sodium	trace.
Phosphate of soda	trace.
Biborate of soda	trace.
Sulphate of lime	35·013
Bi-carbonate of lime	25.464
" magnesia	15·844
" iron	trace.
Silica	0 707
Organic matter	trace.
	1002·152
Carbonic acid, free	8·488
	1010·640

The water was examined for barium and strontium, and these were both found to be absent.

2.—Water from a boring near the mouth of Pelican River, on the Athabasca River, district of Alberta, North-west Territory. Taken from a depth of between 225 and 250 feet. Issues from the Grand Rapids Sandstones, Cretaceous.

The water contained a trifling amount of pale brown flocculent matter in suspension, which was removed by filtration. The filtered water was clear and bright; had a faint brownish-yellow colour, and a mildly saline taste. Reaction, faintly alkaline; when evaporated to a small volume, strongly so. Its specific gravity, at 15.5° C., was found to be 1003·18. Boiling produced a very slight precipitate, consisting of carbonates of lime and magnesia.

One thousand parts, by weight, of the filtered water at 15·5° C., were found to contain:

Potassa	0·013
Soda	1·587
Lithia	trace.
Lime	0·006
Magnesia	0·007
Ferrous oxide	trace.
Sulphuric acid	0·001
Boric acid	strong trace.
Carbonic acid	1·257
Chlorine	0·859
Bromine	trace.
Iodine	trace.
Silica	0·012
Organic matter	trace.
	3·742
Less oxygen equivalent to chlorine	0·193
	3·549

The foregoing acids and bases may reasonably be assumed to be present in the water in the following state of combination:

(The carbonates being calculated as monocarbonates, and all the salts estimated as anhydrous.)

Chloride of sodium		1·415
Bromide of sodium		trace.
Iodide of sodium		trace.
Sulphate of potassa		0·002
Biborate of soda		trace.
Carbonate of soda		1·433
"	potassa	0·018
"	lithia	trace.
"	lime	0·011
"	magnesia	0·015
"	iron	trace.
Silica		0·012
Organic matter		trace.
		2·906
Carbonic acid, half-combined		0·614
"	free	0·029
		3·549

Total dissolved solid matter, by direct experiment, dried at 180° C., 2·861.

An imperial gallon of the water, at 15·5° C., would contain:

(The carbonates being calculated as anhydrous bicarbonates, and the salts without their water of crystallization.)

		Grains.
Chloride of sodium		99·365
Bromide of sodium		trace.
Iodide of sodium		trace.
Sulphate of potassa		0·140
Biborate of soda		trace.
Bicarbonate of soda		142·412
"	potassa	1·685
"	lithia	trace.
"	lime	1·124
"	magnesia	1·615
"	iron	trace.
Silica		0·843
Organic matter		trace.
		247·184
Carbonic acid, free		2·036
		249·220

Barium and strontium were sought for, but not detected.

3.—Water from a boring at Victoria, on the Saskatchewan River, below Edmonton, district of Alberta, North-west Territory; taken from a depth of about 1,600 feet. It rises from beds of sandstone and shale of Cretaceous age.

The sample received for examination, contained a small quantity of suspended matter of a brownish-yellow colour which, on removal by filtration, was found to consist of argillaceous matter, together with a little hydrated peroxide of iron and small quantities of carbonates of lime and magnesia. The filtered water was clear, colourless and bright. It had a strong saline taste. Reaction, neutral—both before and after concentration. The specific gravity, at 15·5° C., was found to be 1037·81. Boiling produced no precipitate.

One thousand parts, by weight, of the filtered water, at 15·5° C., were found to contain :

Potassa	0·147
Soda	23·757
Lithia	trace.
Baryta	trace.
Strontia	trace.
Lime	1·989
Magnesia	1·022
Ferrous oxide	trace.
Sulphuric acid	0·003
Boric acid	trace.
Carbonic acid	0·099
Chlorine	31·569
Bromine	trace.
Iodine	strong trace.
Silica	0·005
	58·591
Less oxygen, equivalent to chlorine	7·114
	51·477

The foregoing acids and bases may reasonably be assumed to be present in the water in the following state of combination :

(The carbonate being calculated as monocarbonate, and all the salts estimated as anhydrous.)

Chloride of potassium	0·229
" sodium	44·831
" lithium	trace.
" calcium	3·818
" magnesium	2·426
Bromide of magnesium	trace.
Iodide of magnesium	trace.
Sulphate of potassa	0·006
Biborate of soda	trace.
Carbonate of baryta	trace.
" strontia	trace.

Carbonate of lime	0·112
" iron	trace.
Silica	0·005
	51·427
Carbonic acid, half-combined	0·050
	51·477

Total dissolved solid matter, by direct experiment, dried at 180° C., = 51·451.

An imperial gallon of the water, at 15·5° C., would contain :

(The carbonate being calculated as anhydrous bicarbonate, and the salts without their water of crystallization.)

	Grains.
Chloride of potassium	16·636
" sodium	3256·824
" lithium	trace.
" calcium	277·365
" magnesium	176·241
Bromide of magnesium	trace.
Iodide of magnesium	trace.
Sulphate of potassa	0·436
Biborate of soda	trace.
Bicarbonate of baryta	trace.
" strontia	trace.
" lime	11·769
" iron	trace.
Silica	0·363
	3739·634

4.—Water from a spring at 'The Gap,' east entrance to Crow Nest Pass, township seven, range three, west of the fifth initial meridian, district of Alberta, North-west Territory.

The sample of water sent for examination had, when received a faint, yet decided, odour of sulphuretted hydrogen ; and contained a very trifling amount of pale brown, flocculent, organic, apparently vegetable, matter in suspension. This was removed by filtration. The water was colourless, and tasted somewhat insipid. Reaction, neutral ; after evaporation to a small volume, however, very faintly alkaline. Its specific gravity, at 15·5° C., was found to be 1000·25. Boiling produced a slight precipitate, consisting of carbonates of lime and magnesia.

One thousand parts, by weight, of the filtered water, at 15·5° C., were found to contain :

Potassa	trace.
Soda	0·015
Lithia	trace.
Lime	0·126

Magnesia	0·047
Ferrous oxide	trace.
Sulphuric acid	0·135
Carbonic acid	0·096
Chlorine	0·003
Silica	0·004
Organic matter	trace.
	0·426
Less oxygen, equivalent to chlorine	0·001
	0·425

The foregoing acids and bases may reasonably be assumed to be present in the water in the following state of combination :

(The carbonates being calculated as monocarbonates, and all the salts estimated as anhydrous.)

Chloride of potassium	trace.
" sodium	0·005
Sulphate of soda	0·027
" lime	0·204
Carbonate of lithia	trace.
" lime	0·075
" magnesia	0·099
" iron	trace.
Silica	0·004
Organic matter	trace.
	0·414
Carbonic acid, in excess of that required to form monocarbonates	0·011
	0·425

Total dissolved solid matter, by direct experiment, dried at 180° C., = 0·428.

The carbonic acid found amounted, it may be observed, to little more than that required to form neutral carbonates ; hence, but a very small proportion of these would appear to be present in the water as bicarbonates.

An imperial gallon of the water, at 15·5° C., would contain :

(The carbonates being calculated as monocarbonates, and all the salts estimated as anhydrous.)

	Grains.
Chloride of potassium	trace.
" sodium	0·350
Sulphate of soda	1·890
" lime	14·284
Carbonate of lithia	trace.
" lime	5·251

Carbonate of magnesia	6·932
" iron	trace.
Silica	0·280
Organic matter	trace.
	28·987
Carbonic acid, in excess of that required to form monocarbonates	0·770
	29·757

Barium, strontium, boric acid, bromine and iodine, were sought for, and found to be absent.

5.—Water from Goodenough Lake, one of several soda lakes, situate some twenty-eight miles north of Clinton, Lillooet district, in the province of British Columbia. The lake in question has been more fully referred to under 'natron' on p 12., ante, where will also be found some information in regard to the conditions of the lake obtaining at the time of the collection of the sample of water, of which the following are the results of an examination.

It contained a little pale brown, flocculent, organic matter in suspension, which was removed by filtration, leaving the water perfectly clear and colourless. It was devoid of any marked odour. It tasted and reacted strongly alkaline. It specific gravity, by hydrometer, at 15·5° C., was found to be 1108·5.

One thousand parts, by weight, of the filtered water, at 15·5° C., were found to contain :

Potassa	8·300
Soda	50·446
Ammonia, very small quantity	undet.
Lime	0·023
Magnesia	0·062
Alumina	0·345
Sulphuric acid	6·105
Phosphoric acid	0·576
Boric acid	trace.
Carbonic acid	42·151
Chlorine	7·902
Silica	0·041
Organic matter, small quantity	undet.
	115·951
Less oxygen, equivalent to chlorine	1·780
	114·171

The foregoing acids and bases may reasonably be assumed to be present in the water in the following state of combination:

(The carbonates being calculated as monocarbonates, and all the salts estimated as anhydrous.)

Chloride of sodium	13·021
Sulphate of potassa	13·294
Carbonate of potassa	1·630
" soda	74·236
" ammonia, very small quantity	undet.
" lime	0·041
" magnesia	0·130
Phosphate of soda	0·222
" alumina	0·825
Biborate of soda	trace.
Silica	0·041
Organic matter, small quantity	undet.
	103·440
Carbonic acid, in excess of that required to form monocarbonates	10·731
	114·171

The amount of carbonic acid found, in excess of that required to form normal carbonates, is little more than one-third that required by these to form bicarbonates, from which it would appear that only a portion of the neutral carbonates are present in the water in the latter condition.

An imperial gallon of the water at 15·5° C., would contain:

(The carbonates being calculated as monocarbonates, and all the salts estimated as anhydrous.)

	Grains.
Chloride of sodium	1010·365
Sulphate of potassa	1031·548
Carbonate of potassa	126·480
" soda	5760·342
" ammonia,—very small quantity	undet.
" lime	3·181
" magnesia	10·087
Phosphate of soda	17·226
" alumina	64·016
Biborate of soda	trace.
Silica	3·181
Organic matter, small quantity	undet.
	8026·426
Carbonic acid, in excess of that required to form monocarbonates	832·672
	8859·098

Lithium, barium, strontium, bromine and iodine, were sought for, and found to be absent.

The results of an examination of the mud forming the bottom of the lake in which this water occurs, are given on a preceding page,—see under 'natron.'

6.—Water from a spring within a few miles of St. Peters, Richmond county, province of Nova Scotia. Examined for the Rev. J. Fraser.

This water, at the time of its receipt, contained a small quantity of reddish-brown suspended matter which, on removal by filteration, was found to consist of organic matter with a little hydrated peroxide of iron. The filtered water had a pale brownish-yellow colour ; a distinctly saline teste ; reacted neutral, both before and after concentration ; and had a specific gravity, at 15·5° C., of 1009.0. It contained 11·256 parts of dissolved saline matter, dried at 180° C., in 1000 parts, by weight, of the water,—equivalent to 795·011 grains per imperial gallon.

A qualitative analysis indicated the presence of :

Soda	rather large quantity.
Lime	somewhat large quantity.
Magnesia	very small quantity.
Sulphuric acid	rather small quantity.
Carbonic acid	small quantity.
Chlorine	rather large quantity.
Silica	trace.
Organic matter	faint trace.

Boiling produced a small precipitate consisting, for the most part, of carbonate of lime, with a very little carbonate of magnesia.

7.—Water from a boring at Eel River Crossing, Restigouche county, province of New Brunswick. Examined for Mr. Wm. Currie.

This, when received, contained a small amount of pale brown, flocculent, suspended matter which, on removal by filtration, was found to consist of organic matter with a little hydrated peroxide of iron. The filtered water was slightly turbid and became still more so on exposure to the air at the same time assuming a brownish-yellow colour, and ultimately depositing a little ferric hydrate. It had a very mild saline taste, and a faint, yet marked putrescent odour. Reaction neutral—after concentration, however, very faintly alkaline. Its specific gravity, at 15·5° C., was found to be 1001·5. It contained 1·669 parts of dissolved saline

matter, dried at 180° C., in 1,000 parts, by weight, of the water, —equivalent to 117·04 grains per imperial gallon.

A qualitative analysis showed it to contain :

Potassa	trace.
Soda	large quantity.
Lithia	trace.
Lime	very small quantity.
Magnesia	very small quantity.
Ferrous oxide	trace.
Sulphuric acid	very small quantity.
Carbonic acid	small quantity.
Chlorine	rather large quantity.
Silica	trace.
Organic matter	strong trace.

Boiling produced a slight precipitate, consisting of carbonates of lime and magnesia, and hydrated peroxide of iron.

8.—Water from a boring at Dunsinnane, Kings county, province of New Brunswick. The main flow of the water was struck at a depth of about three hundred feet. Examined for Mr. John White.

The sample received for examination contained a trifling amount of white, flocculent, suspended matter. This was removed by filtration. The filtered water had a faint brownish-yellow colour, was odourless, and had an insipid taste. Reaction, neutral—when reduced to a small volume, however, faintly alkaline. Total dissolved saline matter, dried at 180° C., amounted to 0·114 parts per 1,000—equivalent to 7·98 grains per imperial gallon.

A qualitative analysis indicated the presence of :

Soda	small quantity.
Lime	very small quantity.
Magnesia	very small quantity.
Sulphuric acid	very small quantity.
Carbonic acid	very small quantity.
Chlorine	small quantity.
Silica	trace.
Organic matter	faint trace.

Boiling produced but a very slight precipitate, consisting, for the most part, of carbonate of lime with a very little carbonate of magnesia.

9.—Water from a spring on the property of Mr. Edouard Têtu, a mile and a half from Montmagny Station, on the line of the Intercolonial Railway,—cadastral lot 184 of St. Thomas, Montmagny county, province of Quebec. Received from Mr. J. Obalski.

The sample of water received for examination, contained a small quantity of brownish flocculent matter in suspension, which, on removal by filtration, was found to consist of organic matter with a very little hydrated peroxide of iron. The filtered water had a pale brownish-yellow colour; was devoid of odour; and tasted mildly saline. Reaction, neutral, but after concentration, faintly alkaline. It had a specific gravity, at 15·5° C., of 1004·5, and was found to contain 6·180 parts of dissolved saline matter, dried at 180° C., in 1,000 parts, by weight, of the water,—equivalent to 434·55 grains per imperial gallon.

A qualitative analysis showed it to contain:

Potassa	trace.
Soda	somewhat large quantity.
Lime	small quantity.
Magnesia	small quantity.
Ferrous oxide	trace.
Carbonic acid	rather small quantity.
Chlorine	somewhat large quantity.
Silica	trace.
Organic matter	trace.

Boiling produced a small precipitate, consisting of carbonates of lime and magnesia with traces of hydrated peroxide of iron.

10.—Water from a spring in St. Ferdinand d'Halifax, Lake William, township of South Halifax, Megantic county, province of Quebec. Examined for Mr. A. Chambrier.

The sample of water sent for examination, contained a trifling amount of pale brownish, flocculent, organic matter in suspension. After removal of this by filtration, the water was found to be bright, colourless, odourless, and devoid of any marked taste. It reacted neutral, both before and after concentration. Its specific gravity at 15·5° C., was found to be 1000·49. It contained 0·140 parts of dissolved saline matter, dried at 180° C., in 1,000 parts, by weight, of the water,—equivalent to 9·805 grains per imperial gallon.

A qualitative analysis indicated the presence of:

Soda	very small quantity.
Lime	small quantity.
Magnesia	very small quantity.
Sulphuric acid	very small quantity.
Carbonic acid	small quantity.
Chlorine	very small quantity.
Silica	trace.
Organic matter	faint trace.

Boiling produced a very slight precipitate, consisting of carbonate of lime with a very little carbonate of magnesia.

11.—Water from a spring on the farm of Mr. John Kennedy, on the south half of lot one, concession A of Rideau Front, township of Nepean, Carleton county, province of Ontario. Examined for Mr. A. F. McIntyre.

The sample of water received for examination contained a small quantity of pale brown, flocculent, organic matter in suspension. This was removed by filtration. The filtered water, which was perfectly bright, had a faint brownish-yellow colour. It was devoid of any marked taste. Reaction, neutral; when evaporated to a small volume, however, strongly alkaline. Its specific gravity, at 15·5°C., was found to be 1000·47. The total dissolved saline matter, dried at 180°C., amounted to 0·440 parts per 1000,—equivalent to 30·8 grains per imperial gallon.

A qualitative analysis showed it to contain:

Potassa	very small quantity.
Soda	small quantity.
Lithia	trace.
Lime	small quantity.
Magnesia	very small quantity.
Alumina	trace.
Ferrous oxide	trace.
Sulphuric acid	small quantity.
Boric acid	faint trace.
Carbonic acid	rather small quantity.
Chlorine	very small quantity.
Silica	trace.
Organic matter	trace.

Boiling produced a slight precipitate, consisting of carbonates of lime and magnesia. Baryta, strontia, bromine and iodine, were sought for, and found to be absent.

12.—Water from a spring on the twenty-first lot of the third concession of the township of Huntley, Carleton county, province of Ontario. Examined for Mr. James Wilson.

It contained a little brownish flocculent matter in suspension, which, on removal by filtration, was found to consist of organic matter with a little hydrated peroxide of iron. The filtered water had a faint brownish-yellow colour; was odourless; and possessed a very mildly saline taste. Reaction, neutral; when evaporated to a small volume, however, decidedly alkaline. Specific gravity, by hydrometer, at 15·5°C., 1002·0. Total dissolved saline matter, dried at 180°C., 2·715 parts per 1000,—equivalent to 190·43 grains per imperial gallon.

A qualitative analysis showed the presence of :

Soda	rather small quantity.
Lime	very small quantity.
Maguesia	small quantity.
Sulphuric acid	trace.
Carbonic acid	small quantity.
Chloriue	rather small quautity.
Silica	trace.
Organic matter	trace.

Boiling produced a slight precipitate, consisting of carbonate of lime with a little carbonate of magnesia.

13.—Water from a boring in the town of Souris, Brandon, province of Manitoba.

The sample of the water submitted to examination contained a small amount of pale brown flocculent matter in suspension which, on removal by filtration, was found to consist of hydrated peroxide of iron with a little carbonate of lime and a trifling quantity of organic matter. The filtered water was clear and colourless; devoid of odour, and any marked taste. Reaction, neutral,—after concentration, however, strongly alkaline. Its specific gravity, at 15·5°C., was found to be 1001·5. The total dissolved saline matter, dried at 180°C., amounted to 1·522 parts per 1,000,—equivalent to 106·68 grains per imperial gallon.

A qualitative analysis indicated the presence of :

Soda	small quantity.
Lime	small quantity.
Magnesia	small quantity.
Ferrous oxide	trace.
Sulphuric acid	small quautity.
Carbonic acid	somewhat large quantity.
Chlorine	small quantity.
Silica	trace.
Organic matter	trace.

Boiling produced a small precipitate, consisting of carbonates of lime and magnesia with a trace of hydrated peroxide of iron.

14.—Water from a spring near Nakusp, east side of Upper Arrow Lake, West Kootenay district, province of British Columbia. Examined for Mr. H. M. McCutcheon.

It contained a trifling amount of white, flocculent, organic matter in suspension. This was removed by filtration. The filtered water was devoid of odour and any marked taste. Reaction, neutral—both before and after concentration. Its specific gravity, at 15·5°C., was found to be 1000·5. It contained 0·51

parts of dissolved saline matter, dried at 180°C., in 1,000 parts, by weight, of the water,—equivalent to 35·7 grains per imperial gallon.

A qualitative analysis showed it to contain:

Potassa	trace.
Soda	very small quantity.
Lime	very small quantity.
Magnesia	very trifling quantity.
Sulphuric acid	small quantity.
Carbonic acid	trace.
Chlorine	very small quantity.
Silica	trace.
Organic matter	trace.

Boiling produced a scarcely perceptible precipitate.

MISCELLANEOUS EXAMINATIONS.

1.—Clay. From Big Pond, Cape Breton county, province of Nova Scotia. A light grayish, friable, non-calcareous, argillaceous earth, containing a somewhat large amount of very fine silicious grit, and some root fibres. In the moist condition, it is distinctly plastic. When burnt it assumes a light reddish-brown colour. It is very difficultly fusible.

2.—Clay. From the forty-fifth lot of the fourth range of the township of Macpès—where it occurs on a small stream called La Petite Paquette, a tributary of the Petite Neigette River,—county of Rimouski, in the province of Quebec. A brownish-yellow, slightly ferruginous, non-calcareous, plastic clay, containing but little gritty matter. When burnt it assumes a reddish-brown colour. It is very difficultly fusible at a high temperature. This clay is well suited for the manufacture of ordinary building brick and common pottery. It might also be used for the manufacture of stove-linings, or even a fire brick in which a high degree of refractoriness was not called for. The pleasing colour it assumes when burnt might likewise render it, in the opinion of many, suitable for the manufacture of terra cotta ware.

ERRATA.

Page 25 s.—Tables 3 and 4. Exports of Coal the produce of Canada, 1898, for 1,140,029 tons read 1,150,029 tons.

The following changes are necessitated by the above erratum :—

Page 28 s.—Exports of Coal the produce of Canada, for 1,140,029 read 1,150,029.

Home Consumption of Canadian Coal, for 3,032,553 read 3,022,553.

Total Consumption of Coal in Canada, for 6,307,534 read 6,297,534.

Page 29 s.—Table 9. Consumption of Coal in Canada, 1898 :—

Canadian, for 3,032,553 read 3,022,553.
Total, for 6,307,534 read 6,297,534.
Percentage Canadian, for 48·1 read 48·0.
" Imported, for 51·9 read 52·0.
Consumption per capita, for 1·202 read 1·200.

Page 64 s.—Table 1. Production of Copper. Increase in lbs., 1898, for 1,501,660 read 4,446,334.

Page 133 s.—Table 12. Imports of Paraffine Wax Candles. Duty: for 25 per cent read 30 per cent.

GEOLOGICAL SURVEY OF CANADA
G. M. DAWSON, C.M.G., LL.D., F.R.S., Director

SECTION OF

MINERAL STATISTICS AND MINES

ANNUAL REPORT

FOR

1898

ELFRIC DREW INGALL, M.E.

Associate of the Royal School of Mines, England, Mining Engineer to the Geological Survey of Canada.

ASSISTANTS

Theo. C. Denis, B.A.Sc. J. McLeish, B.A.

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST EXCELLENT MAJESTY
1900

No. 698.

To Dr. G. M. Dawson, C.M.G., F.R.S., &c.,
Director Geological Survey of Canada.

Sir,—Herewith permit me to hand you the detailed statistical report of the mineral industries of Canada for 1898. The preliminary summary statement for that year which was completed on February 21, 1899, is of course replaced by the revised statement herein contained.

Since the issue of the last annual report the time of the staff of the Section has been occupied in the collection and compilation of the material, statistical and technological, for this report and with the various other duties devolving upon them. Numerous memoranda have been prepared giving information to inquirers as to mineral resources, industries, &c. Much information of this sort has been gathered from various sources and placed on file in our mining records.

A short time was spent by myself in the apatite and graphite district of Buckingham township, Labelle Co., Quebec, and Mr. Denis made a trip to Champlain, Que., to examine some reported finds of natural gas. He also spent some weeks in Lambton, Essex and Welland counties, Ont., investigating the natural gas and petroleum industries and the mode of occurrence of those mineral products. His notes on these subjects are incorporated with the proper articles in the following pages.

Special mention must be made of the assistance received from Mr. Denis in the preparation of the technological matter for the report and of the important and thorough work of Mr. McLeish dealing with the statistical and economic features of the mineral industries. Acknowledgment is also due to Mrs. Sparks for efficient assistance in the work of the Section.

Thanks are also due to those, although too numerous to mention personally, who by answering our circulars or letters have provided valuable material for the report. Material assistance has also been received from the provincial mining departments of Nova Scotia, Quebec and British Columbia and the Dominion Customs and Inland Revenue Departments.

I am, sir,
Your obedient servant,

ELFRIC DREW INGALL.

Section of Mineral Statistics and Mines,
November 18, 1899.

NOTE.—*Unless otherwise stated, the bearings in this report are all referred to the true meridian.*

EXPLANATORY NOTES.

YEAR AND TON USED.

Except for the figures of imports, which refer to the fiscal year ending June 30 in the current calendar year, the year used throughout this report is the calendar year. The ton is that of 2,000 pounds, unless otherwise stated.

EXPORTS AND IMPORTS.

The figures given throughout the report referring to exports and imports are compiled from data obtained from the books of the Customs Department, and will occasionally show discrepancies, which however, there are no means of correcting.

The exports and imports under the heading of each province do not necessarily represent the production and consumption of the province, e.g., material produced in Ontario is often shipped from Montreal and entered there for export, so falling under the heading, Quebec.

N.E.S. = Not elsewhere specified.

VALUES ADOPTED.

The values of the metallic minerals produced, as per returns to this department, are calculated on the basis of their metallic contents at the average market price of the metal for the current year. Spot values have been adopted for the figures of production of the non-metallic minerals.

GENERAL NOTES.

As in the past, care is taken to avoid interference with private interests in the manner of publishing results, and all returns of production of individual mines are treated as confidential, unless otherwise arranged with those interested. The confidence of the mining community thus gained, has resulted in an increasingly general response to our circulars, although to complete our data personal application is still necessary in a small number of instances, and a yet more prompt response on the part of all applied to, will help still further towards an earlier publication of the material.

In view of criticisms of these statistics which have been made from time to time in the past, it may be well to explain the working methods adopted, in order to prevent the misunderstandings which underlie such criticisms and suggestions, and to correct the impression thereby conveyed to the public that the reports are unreliable.

The figures given throughout the reports are based, as far as possible, upon returns obtained direct from the various operators, or from official data, and the totals have for some years been checked by comparison with railway shipments, exports, and all other available sources of information. It can be therefore fairly claimed, that they are as accurate as it is possible to make such figures.

After investigation of the subject we have, however, found that in the nature of things, export and railway figures can only be taken as approximately correct in most instances. In the case of the export figures, entries are made as a rule by those having no technical knowledge of mineral substances, and in the case of the railways, but few of the shipments are actually weighed, so that car-load lots, for instance, may differ considerably from the theoretical load of the car.

The lists of operators given throughout the report are not put forward as complete in every case, only those reporting their production being included. Producers finding their names omitted are invited to communicate with the office that they may be included in the next issue.

CORRECTIONS—ALTERATIONS.

Corrections and alterations have been made throughout this report wherever they seemed to be called for, according to more complete and reliable data available since previous issues.

The tabulated statement given in the folded sheet facing page 8 represents a compilation of all the similar statements found in previous reports, re-modelled and further revised wherever possible.

INTRODUCTION.

Mineral Production of Canada

The following general table of the 'Mineral Production of Canada' covers a period of thirteen years, commencing with the inauguration of the work of the Mines Section of the Geological Survey. In a condensed form the history of the various mineral industries of Canada will be therein illustrated, the details being given in the body of the report.

Taking the industry as a whole the following points will be noted. The increase in the grand total has been in an ever increasing ratio for the past three years as shown in the below given figures.

Year.	Canada.		United States.	
	Increase per cent in Grand Total.	Production per capita.	Increase per cent in Grand Total.	Production per capita.
	p.c.	$	p.c.	$
1898	34·89	7 32	10·61	9 38
1897	26·90	5 52	1·33	8 66
1896	8·79	4 40	·21	8 73
1895	....	4 09	....	8 90
1890	64·00	3 50	38·97	9 89
1886		2 23		7 76

Taking as a standard the great mineral producing country to the south of us, the growth of Canada's mineral industries is seen to be very encouraging. The percentage of increase in the grand total for the years represented is very much larger, and if the present rate of increase continues in the per capita value of the mineral products, the country should soon stand, in this respect, on an equal footing with the United States. The much more rapid increase in the population of that country must of course be taken into account, keeping down the rate as it does and in some years even resulting in a decrease.

The following table gives the relative importance of the various industries as contributors to the whole.

Mineral Production of Canada.

Proportionate Value of Different Mineral Products, 1898.*

Product.	Contributing over 10 p.c.	Contributing between 10 and 5 p.c.	Contributing between 5 and 1 p.c.	Contributing under 1 p. c.	Total.
1. Gold	35·63				
2. Coal	21·27				
3. Silver	....	6·71			
4. Copper	....	5·52			
5. Bricks (estimated)	....	....	4·91		
6. Nickel	....	....	4·71		
7. Building stone (estimated)	....	....	3·36		
8. Lead	....	....	3·12		
9. Petroleum	....	....	2·75		
10. Lime (estimated)	....	....	1·68		
11. Asbestus	....	....	1·27		
12. Cement	....	....	1·03		
13. Natural gas	....	....	....	·83	
14. Coke	....	....	....	·74	
15. Salt	....	....	....	·64	
16. Gypsum	....	....	....	·60	
17. Tiles	....	....	....	·58	
18. Pottery	....	....	....	·55	
19. Sundry under 1 p.c.	....	....	....	4·10	
Total	56·90	12·23	22·83	8·04	100·00

On comparison of the above with the similar table given in last year's report several important changes are noticeable. Gold heads the list, replacing coal and showing a large increase compared with the 21·02 per cent credited to it in 1897. This is of course nearly all due to the enlarged output from the Yukon. Silver still holds third place although by a much less percentage, and copper and bricks reverse places, coming now in the order named. Lead has dropped from seventh to eighth place, changing with building-stone, and other changes of less importance will be evident.

* In studying a comparative statement such as the tabulation given, it must be remembered that the above percentages are of the gross values, which vary from year to year, not only by reason of varying amounts produced, but also on account of the fluctuations in the price. This latter factor has affected some minerals more than others. The heavy decline in the price of silver, for instance, in the past few years, has very greatly affected its place in the scale, and copper, nickel and asbestus have varied much in this respect. This can be seen by comparison of 1898 with earlier years in the main table, and in order to facilitate this use of the table, the features of increase and decrease have been brought out by the use of differing type as explained in the foot-notes.

GEOLOGICAL SURVEY OF CANADA.

Mineral Production of Canada, Calendar Years 1886 to [illegible]

	1886	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897
[illegible]	2 707 079	2 798 [illegible]	3 217 674	[illegible] 781 271	[illegible]	3 603 [illegible]	5 1[illegible]	[illegible]	[illegible]	[illegible]	4 [illegible] 550	[illegible] 270 166
[illegible]	6 240 [illegible]	6 842 [illegible]	7 264 940	9 137 584	1[illegible] 230 425	[illegible]	1[illegible] 050,641	[illegible]	[illegible]	9 [illegible]	10 [illegible]	11 [illegible] 010
[illegible]	[illegible]	9 640 [illegible]	10 [illegible] 614	12 [illegible]	13 [illegible] 967	[illegible]	1[illegible] 154 587	[illegible]	[illegible]	[illegible]	14 [illegible] 116	16 [illegible]
[illegible]	[illegible]	2 [illegible]	3 251 2[illegible]	3 [illegible]	[illegible] 633,059	[illegible] 808 007	[illegible]	[illegible]	8 073 114	[illegible]	[illegible]	21 [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	300 000
[illegible]	11 321 [illegible]	12 [illegible]	14 [illegible]	1[illegible] 353	18 976 616	[illegible]	20 [illegible]	[illegible]	20 [illegible]	22 [illegible] 813	28 661 430	28 [illegible] 010

In 1897 the metallic products constituted about 48 per cent of the whole as compared with about 56 per cent in 1898, and the non-metallic stand at 36 and 29 per cent in the two years respectively, whilst the structural material class contributed about 15 per cent in the former and nearly 14 per cent in the latter. Mineral Production of Canada.

TABLE OF INCREASES AND DECREASES IN THE PRODUCTION OF THE VARIOUS MINERALS IN 1898, AS COMPARED WITH 1897.

Products.	Quantity.		Value.	
	Increase.	Decrease.	Increase.	Decrease.
	p. c.	p. c.	p. c.	p. c.
Metallic—				
Copper	33·43	....	42·17	....
Gold	128·56	....	128·56	....
Iron ore	15 06	....	17·26	....
Lead	....	18·20	....	13·64
Nickel	38·02	....	30·14	....
Silver	....	20·27	....	21·95
Non-metallic—				
Asbestus and asbestic	....	21·87	10·29	....
Coal	10·21	....	12·58	....
Coke	44·35	....	62·08	....
Gypsum	....	8·53	....	4·91
Natural gas	....	....	....	1·15
Petroleum	6·84	....	4·96	....
Cement	21·92	....	44·43	....

That the year 1898 was a prosperous one for most of the leading mineral industries, will be apparent from a study of the figures given in the preceding table. All the metalliferous products except lead and silver show marked increases, and with the exception of the latter, better prices have enhanced the increases and lessened the decreases. There was also a decided augmentation in the values of the chief non-metallic products with the exceptions of gypsum and natural gas.

The standing of the different provinces with regard to the grand total is as below.

Mineral Production of Canada.

Production by Provinces, 1898.

Province.	Value of Production.	Per cent.
	$	
Nova Scotia	5,303,093	13·7
New Brunswick	444,427	1·1
Quebec	2,572,518	6·7
Ontario	7,941,249	20·5
Manitoba and North-west Territories	11,009,220	28·5
British Columbia	11,390,503	29·5
Total	38,661,010	100·0

British Columbia takes the lead with its coal, placer gold and metalliferous ores. Next comes the North-west Territories with its coal, but chiefly owing its prominent place to the Yukon gold output. Ontario occupies third place, contributing all the nickel, salt, petroleum and natural gas, and largely to the copper, and constituting an important factor in the gold, iron and several other items. Nova Scotia contributes largely to the coal, gold and iron output of the country, and is an important factor in other industries of less importance, and Quebec comes fifth, supplying all the asbestus and chromite and adding to the iron and gold.

The following tables give the exports and imports of mineral substances as gathered from the books of the Customs Department. The former, being for the calendar year, are in a degree comparable with the figures of production. It must, however, be borne in mind, as elsewhere pointed out in the report, that in many items the basis of valuation is very much lower than that adopted by this Section, especially in the case of metals and other ores. As they stand, however, the figures show an exportation of nearly 38 per cent of the total production. Taking these increased values into account, and arriving thus at an approximation of the export figures on the same basis as those of production, the former are found to be about 70 per cent of the latter.

MINERAL PRODUCTION OF CANADA.

Exports.

EXPORTS.

MINERALS AND MINERAL PRODUCTS OF CANADA DURING CALENDAR YEAR 1898.

Products.	Value.	Products.	Value.
Antimony ore	$ 15,295	Mica	$ 110,507
Asbestus, first class	68,578	Mineral pigments	4,227
" second class	197,353	Mineral waters	3,630
" third class	228,081	Nickel	1,019,363
Bricks	442	Oil, crude	4
Cement	2,117	" refined	3,001
Chromite	20,783	Ores, unspecified	30,164
Clay, manufactures of	345	Phosphate	8,240
Coal	3,619,300	Platinum	....
Coke	8,394	Plumbago, crude	11,527
Copper	840,243	" manufactures of	1,571
Felspar	4,396	Pyrites	217,155
Gold	3,352,108	Salt	1,252
Grindstones	18,626	Sand and gravel	90,498
" rough	6,962	Silver	2,902,277
Gypsum, crude	174,907	Slate	....
" ground	6,448	Stone, unwrought	65,370
Iron and steel	593,060	" wrought	2,526
Iron ore	278	Other articles	37,615
Lead	885,485		
Lime	49,594	Total	$14,651,874
Manganese ore	325		
Manufactures of metals other than iron and steel	50,127		

EXPORTS.

DESTINATION OF PRODUCTS OF THE MINE, DURING THE FISCAL YEAR 1897-1898.

Destination.	Value.	Destination.	Value.
United States	$13,838,831	British Guiana	$ 7,976
Great Britain	212,304	China	7,055
Newfoundland	176,727	Japan	4,573
Hawaii	85,595	Chili	1,980
Germany	48,390	Mexico	1,212
British West Indies	24,633	Australia	200
St. Pierre	22,269	France	150
Spanish West Indies	13,089	Danish West Indies	14
Hong Kong	9,678		
Belgium	8,580	Total	$14,463,256

Mineral Production of Canada.

Imports.

IMPORTS.

MINERALS AND MINERAL PRODUCTS, FOR FISCAL YEAR 1897-1898.

Products.	Value.	Products.	Value.
	$		$
Alum and aluminous cake.	38,388	Iron and steel—mfrs. of—	
Aluminum	3,295	Machinery, hardware, &c.	11,373,107
Antimony	12,350	Lead—pigs, bars, bl'ks, old scrap, &c	299,820
Arsenic	14,270	" manufactures of	63,179
Asbestus and mfrs. of	26,389	Lime	9,002
Asphaltum	55,164	Litharge	32,904
Bismuth	562	Lithographic stone	7,767
Blast furnace slag	17,658	Manganese, oxide of	5,047
Borax	59,807	Marble—blocks, slabs, &c.	65,996
Bricks	8,989	" mfrs. of	29,898
" bath	1,583	Mercury	36,425
" and tiles, fire	115,449	Metallic alloys—	
Buhrstones	1,813	Brass and mfrs. of	560,014
Building stone	28,495	Bronze, german silver, pewter, &c	122,219
Cement	10,360	Mineral and bituminous substances, N.E.S.	22,932
" Portland	355,264	Mineral and metallic pigments, paints and colours.	665,882
Chalk	9,338	Mineral waters	52,989
Clay, china	42,570	Nickel	5,882
" fire	22,969	Ores of metals, N.E.S.	155,583
" pipe	816	Paraffine wax	5,987
" all other, N.E.S.	6,440	" candles	4,427
Coal, anthracite	5,874,685	Petroleum and products of.	724,519
" bituminous	3,179,595	Phosphorus	4,618
" dust, &c	45,556	Platinum	9,781
" tar and pitch	35,194	Precious stones	402,158
Coke	347,040	Pumice	3,829
Copper, and mfrs. of	867,443	Salt	326,202
Copperas	2,364	Saltpetre	51,236
Cryolite	2,315	Sand and gravel	43,287
Earthenware	675,874	Slate	24,907
Emery	17,661	Stone and granite, N.E.S.	41,420
" mfrs. of	15,478	Spelter	13,561
Felspar, quartz, flint, &c.	16,402	Sulphate of copper	57,497
Fertilizers	64,515	Sulphur	373,786
Fuller's earth	3,330	Sulphuric acid	5,536
Graphite, crude	1,862	Tiles, sewer pipes, &c	29,611
" mfrs. of	39,803	Tin—pigs, bars, &c. mfrs. of	1,550,851
Grindstones	22,217	Whiting	25,761
Gypsum, crude	1,742	Zinc—pigs, bars, dust, &c.	116,325
" plaster of Paris, &c.	2,318	" mfrs. of	6,963
Iron and steel—			
Pigs, scrap, blooms, &c.	1,075,890		
Rolled—bars, plates, &c., including chrome steel.	3,817,144		
Ferro-silicon, ferro-manganese, &c	22,516	Total	34,293,821

ABRASIVE MATERIALS.

Abrasive Materials.

Grindstones.

Grindstones.—The production of grindstones, under which head is included wood-pulp stones, scythe-stones, &c., was in 1898, 4,935 tons valued at $45,775, or an average value per ton of $9.07. The increase over 1897 was 363 tons or 7·9 per cent in quantity and $2,435 or 5·7 per cent in value.

Table 1 shows the production in Nova Scotia and New Brunswick since 1886:—

TABLE 1.

ABRASIVE MATERIALS.

ANNUAL PRODUCTION OF GRINDSTONES.

Calendar Year.	Nova Scotia.		New Brunswick.		Total.		Average Value per Ton.
	Tons.	Value.	Tons.	Value.	Tons.	Value.	
1886	1,765	24,050	2,255	22,495	4,020	46,545	$11.58
1887	1,710	25,020	3,582	38,988	5,292	64,008	12.10
1888	1,971	20,400	3,793	30,729	5,764	51,129	8.87
1889	712	7,128	2,692	23,735	3,404	30,863	9.07
1890	850	8,536	4,034	33,804	4,884	42,340	8.67
1891	1,980	19,800	2,499	22,787	4,479	42,587	9.51
1892	2,462	27,610	2,821	23,577	5,283	51,187	9.69
1893	2,112	21,000	2,488	17,379	4,600	38,379	8.34
1894	2,128	16,000	1,629	16,717	3,757	32,717	8.71
1895	1,400	14,000	2,075	17,932	3,475	31,932	9.19
1896	1,450	14,500	2,263	18,810	3,713	33,310	8.97
1897	1,407	17,500	3,165	24,840	4,572	42,340	9.26
1898	1,422	12,350	3,513	32,425	4,935	44,775	9·07

About 170 men were employed for various periods of time ranging from three to six months.

Abrasive Materials.

The exports of grindstones are given in Tables 2 and 3 below :—

Grindstones.

Table 2.

Abrasive Materials.

Exports of Grindstones.

Calendar Year.	Value.
1884	$28,186
1885	22,606
1886	24,185
1887	28,769
1888	28,176
1889	29,982
1890	18,564
1891	28,433
1892	23,567
1893	21,672
1894	12,579
1895	16,723
1896	19,139
1897	18,807
1898	18,626

Table 3.

Abrasive Materials.

Exports of Grindstones by Provinces.

Provinces.	Calendar Year.				
	1894.	1895.	1896.	1897.	1898.
Quebec	$ 1	....	....	$ 112	... .
Nova Scotia	10,048	$ 8,723	$ 12,145	12,094	$ 9,240
New Brunswick	2,530	8,000	6,994	6,601	9,386
Totals	$ 12,579	$ 16,723	$ 19,139	$ 18,807	$ 18,626

Besides the exports from New Brunswick given in the table, there was exported from that province stone for the manufacture of grindstones, 837 tons at a value of $6,962.

Abrasive Materials.

Grindstones.

TABLE 4.

ABRASIVE MATERIALS.

IMPORTS OF GRINDSTONES.

Fiscal Year.	Duty.	Tons.	Value.
1880	....	1,044	$11,714
1881	....	1,359	16,895
1882	....	2,098	30,654
1883	....	2,108	31,456
1884	....	2,074	30,471
1885	....	1,148	16,065
1886	....	964	12,803
1887	....	1,309	14,815
1888	....	1,721	18,263
1889	....	2,116	25.564
1890	....	1,567	20,569
1891	....	1,381	16,991
1892	....	1,484	19,761
1893	....	1,682	20,987
1894	....	1,918	24,426
1895	....	1,770	22,834
1896	....	1,862	26,561
1897	....	1,521	25,547
1898 { Grindstones, not mounted and not less than 36 inches in diameter	15 p.c.	....	18,010
1898 { Grindstones N.E.S......	25 p.c.	....	4,207
			22,217

Buhrstones.

TABLE 5.

ABRASIVE MATERIALS.

IMPORTS OF BUHRSTONES.

Fiscal Year.	Value.
1880	$12,049
1881	6,337
1882	15,143
1883	13,242
1884	5,365
1885	4,517
1886	4,062
1887	3,545
1888	4,753
1889	5,465
1890	2,506
1891	2,089
1892	1,464
1893	3,552
1894	3,029
1895	2,172
1896	2,049
1897	1,827
*1898	1,813

*Buhrstones in blocks, rough or unmanufactured, not bound up or prepared for binding into mill-stones. Duty free.

Abrasive Materials.

Emery.

Table 6.

Abrasive Materials.

Imports of Emery.

Fiscal Year.	Emery. a.	Mfrs. of Emery. b.
1885	$ 5,066	4,920
1886	11,877	5,832
1887	12,023	4,598
1888	15,674	4,001
1889	13,565	3,948
1890	16,922	5,313
1891	16,179	6,665
1892	17,782	6,492
1893	17,762	5,606
1894	14,433	2,223
1895	14,569	7,775
1896	16,287	11,913
1897	16,318	11,231
1898	17,661	15,478

a Emery, in bulk, crushed or ground. Duty free.

b Emery wheels and manufactures of emery. Duty 25 p.c.

Table 7.

Abrasive Materials.

Pumice stone.

Imports of Pumice Stone.

Fiscal Year.	Value.
1885	$ 9,384
1886	2,777
1887	3,594
1888	2,890
1889	3,232
1890	3,003
1891	3,696
1892	3,282
1893	3,798
1894	4,160
1895	3,609
1896	3,721
1897	2,903
*1898	3,829

* Pumice and pumice stone, ground or unground. Duty free.

ASBESTUS.

Asbestus.

Production.

The production of asbestus and asbestic in Canada during the past three years has been as follows :—

—	Tons.	Value.	Average Value per Ton.
1896—Asbestus	10,892	$ 423,066	$ 38 84
Asbestic	1,358	6,790	5 00
	12,250	$ 429,856	$ 35 09
1897—Asbestus	13,202	$ 399,528	$ 30 26
Asbestic	17,240	45,840	2 66
	30,442	$ 445,368	$ 14 63
1898—Asbestus	16,124	$ 475,131	$ 29 46
Asbestic	7,661	16,066	2 10
	23,785	$ 491,197	$ 20 65

The increase in the production of asbestus in 1898 over 1897 was 2,922 tons or 22 per cent as compared with an increase of 17·5 per cent in 1897 over 1896.

As usual the grade of fibre produced has a wide range. The highest grade of long fibre is worth from $80 to $200 per ton but is produced only in small quantities. Second grade ranges in value from $35 to $65 and thirds are worth from $10 to $30. A very large proportion of the production of the year is of the short fibre and consequently the average value per ton still remains much lower than what it was previous to 1896, when the higher grade material formed a larger percentage of the total.

Asbestus.

The production, &c., for the years previous to 1896 are as follows:—

Table 1.

Asbestus.

Production.

Production, &c.

Calendar Year.	Production.			Exports, Average value per ton.
	Tons (2,000 lbs.)	Value.	Average value per ton.	
		$	$ cts.	$ cts.
1880	380	24,700	65 00	Exports taken as production.
1881	540	35,100	65 00	
1882	810	52,650	65 00	
1883	955	68,750	71 98	
1884	1,141	75,097	65 80	
1885	2,440	142,441	58 37	
1886	3,458	206,251	59 64	
1887	4,619	226,976	49 14	63 25
1888	4,404	255,007	57 90	70 56
1889	6,113	426,554	69 77	64 44
1890	9,860	1,260,240	127 81	75 52
1891	9,279	999,878	107 75	70 07
1892	6,082	390,462	64 19	69 35
1893	6,331	310,156	49 02	57 24
1894	7,630	420,825	55 15	59 82
1895	8,756	368,175	42 05	56 66

As for asbestic, the production as yet greatly exceeds the demand, there having been over 50,000 tons produced during the year. The sales of this product, however, in 1898, have not maintained the standard set in the previous year and amounted to only 7,661 tons. Doubtless, when the product becomes better known as a wall plastering material, its use will become more extended and the demand for it will increase proportionately.

The statistics of the exports and imports of asbestus are shown in Tables 2 and 3 below : Asbestus.

TABLE 2.

ASBESTUS.

EXPORTS.

Exports.

Calendar Year.	Tons.	Value.
1892	5,380	$373,103
1893	5,917	338,707
1894	7,987	477,837
1895	7,442	421,690
1896	11,842	567,967
1897	15,570	473,274
1898 1st class	939	$ 68,578
1898 2nd "	4,282	197,353
1898 3rd "	10,125	228,081
Total, 1898	15,346	$494,012

TABLE 3.

ASBESTUS.

IMPORTS.

Imports.

Fiscal Year.	Value.
1885	$ 674
1886	6,831
1887	7,836
1888	8,793
1889	9,943
1890	13,250
1891	13,298
1892	14,090
1893	19,181
1894	20,021
1895	26,094
1896	23,900
1897	19,032
*1898	26,389

* Asbestus, in any form other than crude, and all manufactures of. Duty 25 p.c.

Asbestus.

The mines at Thetford and Danville in Quebec continue to be the chief sources of supply. At Thetford, three companies, the Bells Asbestus Co., (Limited,) King Bros., (Limited,) and the Johnston Asbestus Co., carried on active operations. These companies have well equipped plants and were extending their operations during the year. Over 450 men were employed in the district. Very little work was done at Black Lake. The Anglo-Canadian Asbestus Co. made some shipments from stock in hand and the United Asbestus Co. took out a few hundred tons. The Frankfurter Asbestus Co. was preparing to begin operations in the spring.

At Danville, the Asbestos and Asbestic Co. employs about 250 men, and besides the various grades of asbestus, turns out a large quantity of asbestic. For the latter product, however, they have as yet been unable to find a market for the whole of their production. The property is equipped with first class machinery and is provided with seven boilers capable of yielding over 1,000 H. P. About 10 cable derricks are in use for the purpose of hoisting, the depth of the workings being over 100 feet. A branch railway, 4 miles in length, has been built to connect the mine with the Grand Trunk at Danville.

The only other district in which active work was carried on was in the Ottawa region, where the Denholm mine was purchased and worked by J. W. Wurtelle, of Ottawa. A quantity of high-grade fibre was produced and shipped.

It will be noted that the asbestus exported practically equals in value the production. With the exception of a certain amount of asbestic sold in Canada, the mineral produced goes to foreign manufacturers of asbestus goods.

Chromite.

CHROMITE.

The production of chromite in 1898 was 2,021 tons, valued at an average per ton of \$12, or a total value of \$24,252. Probably more ore than is here represented was taken out of the ground, as these figures represent only the amounts actually sold and shipped from the mines and there were said to be at the end of the year over 4,000 tons of ore in stock awaiting the completion of concentrating machinery, &c.

Compared with the previous years, the production of 1898 was the least since 1894; the first year in which Canadian chromite was mined on any considerable scale. The decrease from the output of 1897 was 616 tons or about 23 per cent. The lessened production in 1898 may

have been due to the fact that several of the largest operators were erecting concentrating machinery and therefore in the meantime purposely restricted the sale of ore; in this case the output next year should show a considerable advance. CHROMITE.

TABLE 1.

CHROMITE.

ANNUAL PRODUCTION. Production.

Calendar Year.	Tons (2,000 lbs.)	Average Price per ton.	Value.
		$ cts.	$
1886	* 60	15 75	945
1887	38	15 00	570
1888 to 1893	no output.		
1894	1,000	20 00	20,000
1895	3,177	13 00	41,300
1896	*2,342	11 53	27,004
1897	2,637	12 31	32,474
1898	*2,021	12 00	24,252

* Railway shipments.

The chromite is obtained entirely from the deposits situated in the "Eastern Townships" of the province of Quebec. The total production of the district up to the end of 1898 was 11,275 tons, at a total value of $146,545. The greater part of the product finds a market in Pittsburg and Philadelphia. The exports for the calendar year have been as follows:—

TABLE 2.

CHROMITE.

EXPORTS. Exports.

Calendar Year.	Tons.	Value.
1895	2,908	$ 42,236
1896	2,466	31,411
1897	2,106	26,254
1898	1,683	20,783

There were no exports recorded for 1894, as that being practically the first year that the ore was mined in Canada the export entries would probably be made under some other heading, such as miscellaneous.

Coal.

COAL.

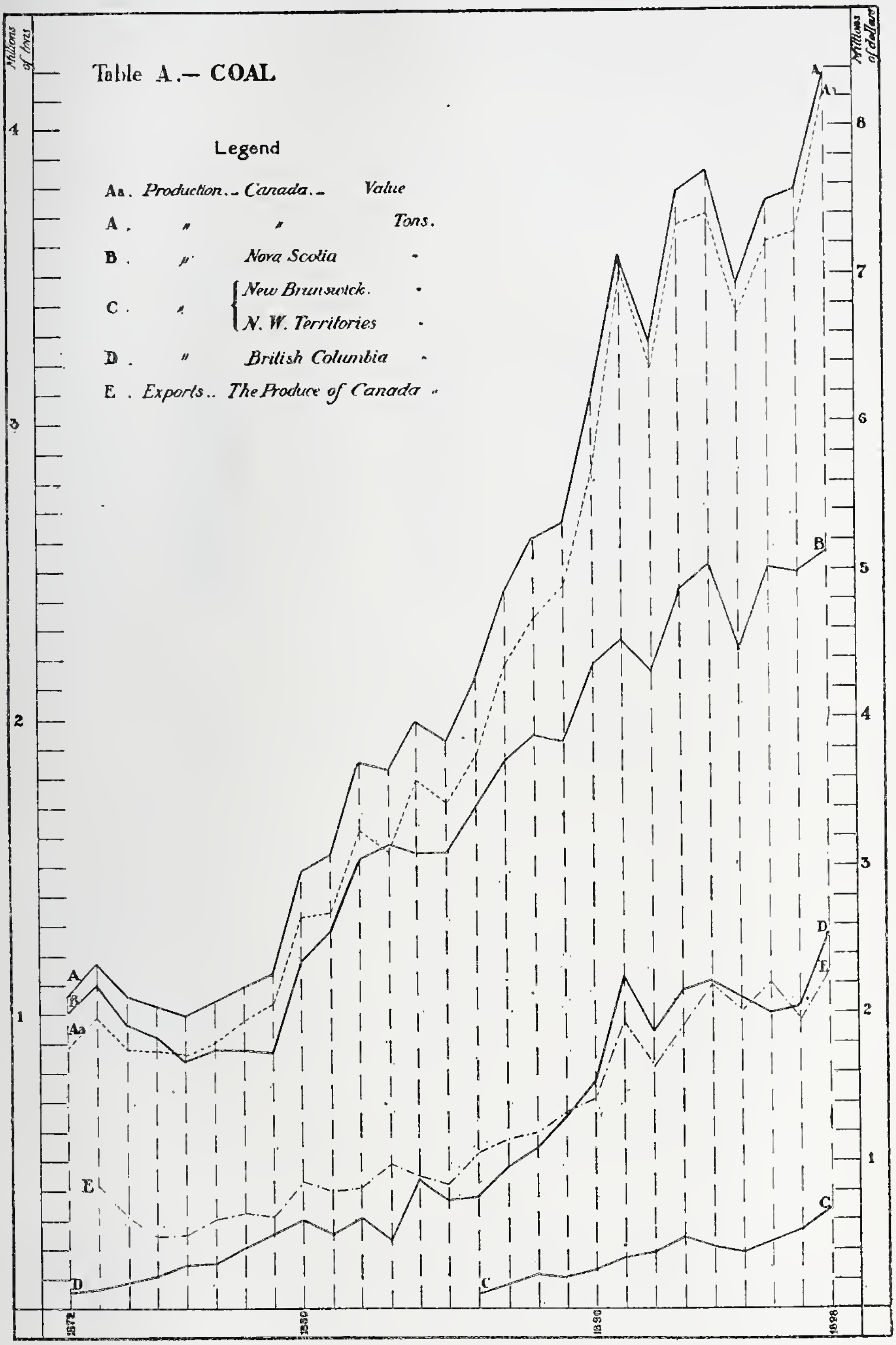
Production.

The general increase in business activity throughout the Dominion in 1898 is to some extent reflected in the statistics of the coal mining industry for the year.

The output of coal in Canada in 1898 shows increases in each of the districts in which it is mined. The total production was 4,172,582 tons of 2,000 lbs. (3,725,520 long tons), valued at $8,222,878, the increase over the production of 1897 being 386,475 tons or 10 per cent in quantity and $919,281 or 11 per cent in value.

Nova Scotia supplied nearly two-thirds of the whole output, or more exactly 61·4 per cent, in 1898; British Columbia in the same year supplying nearly 30·3 per cent, the North-west Territories 8 per cent, the balance, less than one per cent, coming from New Brunswick. In 1897 the proportions were approximately Nova Scotia nearly 66 per cent and British Columbia about 27 per cent. It will thus be seen that the output in British Columbia increased much more rapidly than in Nova Scotia, the percentage of increase being nearly 24 for the former province as compared with nearly 3 for the latter. By comparing the production curves of the two provinces in Graphic Table A, it will be apparent that British Columbia, has been gradually but steadily increasing its proportion of the the total production. The proportions in 1890 were British Columbia 25 per cent, Nova Scotia 71 per cent; in 1880 they were: British Columbia 20 per cent, Nova Scotia, 79 per cent; and in 1874, British Columbia a little over 8 per cent and Nova Scotia 91 per cent.

The production since 1886 is graphically shewn in Table A below :— COAL. Production.



COAL.
Production.

Table 1, which gives the data illustrated graphically in Table A, shows also the average value per ton for the whole Dominion and the increase or decrease in tonnage and the increase or decrease per cent of each year compared with the previous one.

TABLE 1.

COAL.

ANNUAL PRODUCTION SHOWING THE INCREASE OR DECREASE EACH YEAR.

Calendar Year.	Tons.	Value.	Average Value per Ton.	Increase (*i*) or Decrease (*d*), in Tonnage.	Inc. (*i*) or Dec. (*d*) per cent.
1886.....	2,116,653	$3,739,840	$1 77	....	....
1887.....	2,429,330	4,388,206	1 81	*i* 312,677	*i* 14·8
1888.....	2,602,552	4,674,140	1 80	*i* 173,222	*i* 7·1
1889.....	2,658,303	4,894,287	1 84	*i* 55,751	*i* 2·1
1890.....	3,084,682	5,676,247	1 84	*i* 426,379	*i* 16·0
1891.....	3,577,749	7,019,425	1 96	*i* 493,067	*i* 16·0
1892.....	3,287,745	6,363,757	1 94	*d* 290,004	*d* 8·1
1893. ...	3,783,499	7,359,080	1 95	*i* 495,754	*i* 15·1
1894. ...	3,847,070	7,429,468	1 93	*i* 63,571	*i* 1·7
1895.....	3,478,344	6,739,153	1 94	*d* 368,726	*d* 9·6
1896.....	3,745,716	7,226,462	1 93	*i* 267,372	*i* 7·7
1897.....	3,786,107	7,303,597	1 93	*i* 40,391	*i* 1·1
1898.....	4,172,582	8,222,878	1 97	*i* 386,475	*i* 10·2

Table 1*a* shows the increases in each province.

TABLE 1*a*.

COAL.

PRODUCTION.—COMPARISON OF 1897 AND 1898.

Province.	Increase.			
	Tons.	Per cent.	Value.	Per cent.
Nova Scotia.	69,626	2·79	$108,791	2·79
British Columbia....	243,764	23·91	652,938	23·91
North-west Territories	72,925	27·29	157,312	23·20
New Brunswick.............	160	2·66	240	2·66
Dominion...................	386,475	10·21	919,281	11·18

The figures of exports and imports are given in the following tables. They are obtained as in past years from the books and reports of the Customs Department. For 1898 they were the largest in the history of the export trade and amounted to nearly 28 per cent of the year's production.

TABLE 2.

COAL.

EXPORTS.

COAL. Exports.

Calendar Year.	Produce of Canada.	Not Produce.	Calendar Year.	Produce of Canada.	Not Produce.
	Tons.	Tons.		Tons.	Tons.
1873........	420,683	5,403	1886......	520,703	78,443
1874........	310,988	12,859	1887.........	580,965	89,098
1875.........	250,348	14,026	1888.........	588,627	84,316
1876.........	248,638	4,995	1889.........	665,315	89,294
1877.........	301,317	4,829	1890.........	724,486	82,534
1878.......	327,959	5,468	1891......	971,259	77,827
1879........	306,648	8,468	1892.........	823,733	93,988
1880........	432,188	14,217	1893.........	960,312	102,827
1881........	395,382	14,245	1894.........	1,103,694	89,786
1882........	412,682	37,576	1895.........	1,011,235	96,836
1883........	486,811	44,388	1896.........	1,106,661	116,774
1884.........	474,405	62,665	1897.........	986,130	101,848
1885.........	427,937	71,003	1898.........	1,140,029	99,189

TABLE 3.

COAL.

EXPORTS BY PROVINCES.—THE PRODUCE OF CANADA.

Provinces.	Calendar Year.					
	1896.		1897.		1898.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Ontario.......	....	....	......	....	....	....
Quebec.......	....	....	610	$ 1,830	109	$ 218
Nova Scotia...	380,149	$ 787,270	307,128	642,754	309,158	629,363
New Brunswick	1,075	3,364	8,208	25,816	593	1,433
P. E. Island...	....	....	....	....	52	140
N. W. Ter.....	45,638	90,349	39,843	72,188	26,274	39,418
Brit. Columbia.	679,799	2,507,752	630,341	2,221,737	813,843	2,948,428
Total.......	1,106,661	$3,388,735	986,130	$2,964,325	1,140,029	$3,619,000

Coal.

Exports.

TABLE 4.

COAL.

EXPORTS BY PROVINCES.—NOT THE PRODUCE OF CANADA.

Provinces.	Calendar Year.					
	1896.		1897.		1898.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Ontario.........	112,539	$ 222,484	98,062	$ 178,044	98,424	$ 175,436
Quebec.........	28	160	1,143	2,101	12	76
Nova Scotia.....	546	2,064	150	669	176	822
New Brunswick	3,661	9,432	2,493	6,891	267	627
Brit. Columbia.	....	....	....	....	310	1,148
Total........	116,774	$ 234,140	101,848	$ 187,705	99,189	$ 178,109

The exports from Nova Scotia and British Columbia since 1874 are shown together in Table 5.

TABLE 5.

COAL.

EXPORTS.—NOVA SCOTIA AND BRITISH COLUMBIA.

Calendar Year.	Nova Scotia.		*British Columbia.	
	Tons.	Value.	Tons.	Value.
1874..............	252,124	$647,539	51,001	$ 278,180
1875..............	179,626	404,351	65,842	356,018
1876..............	126,520	263,543	116,910	627,754
1877..............	173,389	352,453	118,252	590,263
1878..............	154,114	293,795	165,734	698,870
1879..............	113,742	203,407	186,094	608,845
1880..............	199,552	344,148	219,878	775,008
1881..............	193,081	311,721	187,791	622,965
1882..............	216,954	390,121	179,552	628,437
1883..............	192,795	336,088	271,214	946,271
1884..............	222,709	430,330	245,478	901,440
1885..............	176,287	349,650	250,191	1,000,764
1886..............	240,459	441,693	274,466	960,649
1887..............	207,941	390,738	356,657	1,262,552
1888..............	165,863	330,115	405,071	1,605,650
1889..............	186,608	396,830	470,683	1,918,263
1890..............	202,387	426,070	508,882	1,977,191
1891..............	194,867	417,816	767,734	2,958,695
1892..............	181,547	407,980	599,716	2,317,734
1893..............	203,198	470,695	708,228	2,693,747
1894..............	310,277	633,398	770,439	2,855,216
1895..............	241,091	534,479	728,283	2,692,562
1896..............	380,149	787,270	679,799	2,507,752
1897..............	307,128	642,754	630,341	2,221,737
1898..............	309,158	629,363	813,843	2,948,428

*See foot-note, table 16.

The imports of coal are given in the three following tables:— COAL. Imports.

TABLE 6.

COAL.

IMPORTS OF BITUMINOUS COAL.

Fiscal Year.	Tons.	Value.
1880	457,049	$1,220,761
1881	587,024	1,741,568
1882	636,374	1,992,081
1883	911,629	2,996,198
1884	1,118,615	3,613,470
1885	1,011,875	3,197,539
1886	930,949	2,591,554
1887	1,149,792	3,126,225
1888	1,231,234	3,451,661
1889	1,248,540	3,255,171
1890	1,409,282	3,528,959
1891	1,598,855	4,060,896
1892	1,615,220	4,099,221
1893	1,603,154	3,967,764
1894	1,359,509	3,315,094
1895	1,444,928	3,321,387
1896	1,538,489	3,299,025
1897	1,543,476	3,254,217
*1898	1,684,024	3,179,595

*Duty 53c. per ton.

TABLE 7.

COAL.

IMPORTS OF ANTHRACITE COAL.

Fiscal Year.	Tons.	Value.
1880	516,729	$1,509,960
1881	572,092	2,325,937
1882	638,273	2,666,356
1883	754,891	3,344,936
1884	868,000	3,831,283
1885	910,324	3,909,844
1886	995,425	4,028,050
1887	1,100,165	4,423,062
1888	2,138,627	5,291,875
1889	1,291,705	5,199,481
1890	1,201,335	4,595,727
1891	1,399,067	5,224,452
1892	1,479,106	5,640,346
1893	1,500,550	6,355,285
1894	1,530,522	6,354,040
1895	1,404,342	5,350,627
1896	1,574,355	5,667,096
1897	1,457,295	5,695,168
*1898	1,460,701	5,874,685

*Coal, anthracite, and anthracite coal dust. Duty free.

Coal.
Imports.

TABLE 8.

COAL.

IMPORTS OF COAL DUST.

Fiscal Year.	Tons.	Value.
1880	3,565	$ 8,877
1881	337	666
1882	471	900
1883	8,154	10,082
1884	12,782	14,600
1885	20,185	20,412
1886	36,230	36,996
1887	31,401	33,178
1888	28,808	34,730
1889	39,980	47,139
1890	53,104	29,818
1891	60,127	36,130
1892	82,091	39,840
1893	109,585	44,474
1894	117,573	49,510
1895	181,318	52,221
1896	210,386	53,742
1897	225,562	59,609
*1898	229,445	45,556

*Duty 20 per cent, not over 13c. per ton.

Knowing the production, the imports and the exports, we should be able to arrive at a fair approximation of the consumption of coal in Canada. Assuming that the figures of imports for the fiscal year, as given in Tables 6, 7, and 8 above, represent closely enough the importation of coal during the calendar year, we have the consumption of the country for 1898 as follows:—

	Tons.	Tons.
Production, Table 1	4,172,582	
Exports of coal the produce of Canada, Table 3	1,140,029	
Home consumption of Canadian coal		3,032,553
Imports of bituminous, anthracite and coal dust, Tables 6, 7, and 8	3,374,170	
Exports of coal not the produce of Canada, Table 4	99,189	
Home consumption of imported coal		3,274,981
Total consumption of coal in Canada, home and imported		6,307,534

In Table 9 will be found the results of similar calculations for each year since 1886. There is here shown the consumption of Canadian and

imported coal and the percentage of each as well as the total consumption per capita. The amount of coal used in the country in 1898 is the largest recorded and the proportion of it mined in Canada was slightly greater than last year, amounting to 48·1 per cent. In this respect the year is second only to 1894 when the proportion of the consumption mined in Canada was 48·5 per cent. The amount used per individual of population shows a considerable increase, nearly 7 per cent, over the previous year and is also the highest recorded. COAL. Consumption in Canada.

Taking into consideration the quantity of Canadian coal exported, we are enabled to see the relation between the total production in Canada and the amount consumed in the country. It will thus be seen by comparing tables 1 and 9 that in 1898 the total production amounted to 66·1 per cent of the consumption, while in 1897 the proportion was 63·9 per cent; in 1890 it was 62·4 per cent, and in 1886 it was 60·8 per cent.

TABLE 9.

COAL.

CONSUMPTION OF COAL IN CANADA.

Calendar Year.	Canadian.	Imported.	Total.	Percentage Canadian.	Percentage Imported.	Conumption per capita.
	Tons.	Tons.	Tons.			Tons.
1886	1,595,950	1,884,161	3,480,111	45·9	54·1	·758
1887	1,848,365	2,192,260	4,040,625	45·7	54·3	·871
1888	2,013,925	3,314,353	5,328,278	37·8	62·2	1·137
1889	1,992,988	2,490,931	4,483,919	44·4	55·6	·946
1890	2,360,196	2,581,187	4,941.383	47·8	52·2	1·031
1891	2,606,490	2,980,222	5,586,712	46·7	53·3	1·153
1892	2,464,012	3,082,429	5,546,441	44·4	55·6	1·133
1893	2,823,187	3,110,462	5,933,649	47·6	52·4	1·198
1894	2,743,376	2,917,818	5,661,194	48·5	51·5	1·130
1895	2,467,109	2,933,752	5,400,861	45·7	54·3	1·066
1896	2,639,055	3,206,456	5,845,511	45·1	54·9	1·140
1897	2,799,977	3,124,485	5,924,462	47·3	52·7	1·143
1898	3,032,553	3,274,981	6,307,534	48·1	51·9	1·202

NOVA SCOTIA.

Passing to a consideration of provincial details we have the production of Nova Scotia exhibited in the following tables, 10, 11, 12, 13. Table 10 shows the output, the sales and the colliery consumption in both tons of 2,240 lbs. and tons of 2,000 lbs.

COAL.
Nova
Scotia.

TABLE 10.

COAL.

NOVA SCOTIA :—OUTPUT, SALES, COLLIERY CONSUMPTION AND PRODUCTION.

Calendar Year.	Output, Tons, 2,240 Lbs.	Sales, Tons, 2,240 Lbs.	Colliery Consumption, Tons, 2,240 Lbs.	Production* Tons, 2,240 Lbs.	Output, Tons, 2,000 Lbs.	Sales, Tons, 2,000 Lbs.	Colliery Consumption, Tons, 2,000 Lbs.	Production* Tons, 2,000 Lbs.	Price per Ton, 2,240 Lbs.	Value of Production.
1872	880,950	785,914	110,341	896,255	986,664	880,224	123,582	1,003,806	$1.75	$1,568,446
1873	1,051,467	881,106	108,398	989,504	1,177,643	986,839	121,406	1,108,245	1.75	1,731,632
1874	872,720	749,127	119,582	868,709	977,446	839,022	133,932	972,954	1.75	1,520,240
1875	781,165	706,795	124,110	830,905	874,905	791,610	139,003	930,613	1.75	1,454,084
1876	709,646	634,207	113,788	747,995	794,804	710,312	127,443	837,755	1.75	1,308,991
1877	757,496	687,065	98,841	785,906	848,396	769,513	110,702	880,215	1.75	1,375,339
1878	770,603	693,511	88,627	782,138	863,075	776,732	99,262	875,994	1.75	1,368,741
1879	788,271	688,624	84,787	773,411	882,863	771,259	94,961	866,220	1.75	1,353,469
1880	1,032,710	954,659	96,831	1,051,490	1,156,635	1,069,218	108,451	1,177,669	1.75	1,840,108
1881	1,124,270	1,035,014	107,888	1,142,902	1,259,183	1,159,216	120,834	1,280,050	1.75	2,000,079
1882	1,365,811	1,250,179	111,381	1,361,560	1,529,708	1,400,200	124,747	1,524,947	1.75	2,382,730
1883	1,422,553	1,297,523	111,949	1,409,472	1,593,259	1,453,226	125,383	1,578,609	1.75	2,466,576
1884	1,389,295	1,261,650	116,769	1,378,419	1,556,011	1,413,048	130,781	1,543,829	1.75	2,412,233
1885	1,352,205	1,254,510	127,624	1,382,134	1,514,470	1,405,051	142,939	1,547,990	1 75	2,418,735
1886	1,502,611	1,373,666	142,421	1,516,087	1,682,924	1,538,506	159,512	1,698,018	1.75	2,653,152
1887	1,670,830	1,519,684	139,777	1,659,461	1,871,330	1,702,046	156,550	1,858,596	1.75	2,904,057
1888	1,776,128	1,576,692	157,443	1,734,135	1,989,263	1,765,895	176,336	1,942,231	1.75	3,034,735
1889	1,756,279	1,555,107	158,131	1,713,238	1,967,032	1,741,720	177,107	1,918,827	1.75	2,998,167
1890	1,984,001	1,786,111	161,240	1,947,351	2,222.081	2,000,444	180,589	2,181,033	1.75	3,407,864
1891	2,044,784	1,849,945	174,983	2,024,928	2,290,158	2,071,938	195,981	2,267,919	1.75	3,543,624
1892	1,942,780	1,752,934	175,092	1,928,026	2,175,913	1.963,286	196,103	2,159,389	1 75	3,374,046
1893	2,223,042	1,977,543	205,425	2,182,968	2,489,807	2,214,848	230,076	2,444,924	1.75	3,820,194
1894	2,250,631	2,060,920	196,206	2,257,126	2,520,707	2,308,231	219,751	2,527,982	1.75	3,949,970
1895	1,999,756	1,793,098	193,639	1,986,737	2,239,727	2,008,270	216,875	2,225,145	1.75	3,476,790
1896	2,292,675	2,046,828	192,975	2,239,803	2,567,796	2,292,447	216,132	2,508,579	1.75	3,919,655
1897	2,340,031	2,044,672	181,716	2,226,388	2,620,835	2,290,032	203,522	2,493,554	1.75	3,896,179
1898	2,262,656	2,121,126	167,428	2,288,554	2,534,175	2,375,661	187,519	2,563,180	1.75	4,004,970

* This Production is obtained by adding Sales and Colliery Consumption. For sales previous to 1872, see report of the Department of Mines, Nova Scotia, 1883, page 68.

The coal trade quarterly and by counties is exhibited in Table 11 and the output by collieries in Table 12.

COAL.
Nova Scotia.

TABLE 11.

COAL.

NOVA SCOTIA :—COAL TRADE BY COUNTIES.

Calendar Year.	Cumberland.		Pictou.		Cape Breton.		Other Counties.	
	Raised.	Sold.	Raised.	Sold.	Raised.	Sold.	Raised.	Sold.
	Tons, 2,000 lbs.	Tons, 2,000 lbs.	Tons, 2,000 lbs.	Tons, 2,000 lbs.	Tons, 2,000 lbs.	Tons, 2,000 lbs.	Tons, 2,000 lbs.	Tons, 2,000 lbs.
1st quarter	127,021	101,538	75,541	65,046	128,157	85,458	1,501	728
2nd "	118,621	109,082	118,340	98,801	426,359	419,039	4,806	4,190
3rd "	97,786	92,485	131,823	133,404	669,347	680,478	8,965	7,512
4th "	135,639	127,875	131,388	117,919	353,931	327,198	4,948	4,907
Totals, 1898	479,067	430,980	457,092	415,170	1,577,794	1,512,173	20,220	17,337
" 1897	423,156	352,544	473,458	418,065	1,710,800	1,509,909	13,422	9,514

Coal.
Nova Scotia.

TABLE 12.

COAL.

NOVA SCOTIA :—OUTPUT BY COLLIERIES DURING THE CALENDAR YEAR 1898.

Colliery.	Tons, 2,000 lbs.	Colliery.	Tons, 2,000 lbs.
Cumberland Co.		*Victoria Co.*	
Joggins	76,284	Cape Breton	13,929
Scotia	1,004	*Cape Breton Co.*	
Springhill	401,825	Sydney	299,906
Pictou Co.		Dominion Coal Co.—	
Acadia	227,823	Old Bridgeport	177,378
Intercolonial	229,270	Caledonia	298,292
Inverness Co.		International	105,218
Broad Cove	5,927	Reserve	237,229
Mabou	319	Hub	83,525
		Dominion No. 1	369,852
		Greener	6,394
		Total	2,534,175

The distribution of the coal sold is shown in Table 13. But little variation in the markets for the coal sold is indicated, the expected shipments of large quantities of gas coal from the Cape Breton collieries to Boston not yet having commenced. It is expected that at least 700,000 tons per annumn will be shipped for this purpose. A company is also being formed for the manufacture of iron in Cape Breton on a large scale which will require considerable quantities of coal. If these expectations are realized it will mean a considerable increase in the production of the Nova Scotia collieries.

TABLE 13.

COAL.

NOVA SCOTIA :—DISTRIBUTION OF COAL SOLD.

Market.	Calendar Years. 1897.		1898.	
	Tons, 2,000 lbs.	Per cent.	Tons, 2,000 lbs.	Per cent.
Nova Scotia, transported by land	366,801	16·0	384,976	16·2
" " " sea	363,166	15·9	355,354	15·0
Total, Nova Scotia	729,967	31·9	740,330	31·2
New Brunswick	280,812	12·3	314,327	13·2
Prince Edward Island	73,132	3·2	71,177	3·0
Quebec	1,003,920	43·8	1,045,388	44·0
Newfoundland	99,495	4·3	92,473	3·9
West Indies	103	......	......	......
United States	102,604	4·5	110,948	4·7
Other countries	......	......	1,018	......
Total	2,290,033	100·0	2,375,661	100·0

New Brunswick.

Coal.
New Brunswick.

The statistics of production of coal in New Brunswick are shown in Table 14 below:—

Table 14.

Coal.

New Brunswick:—Production.

Calendar Year.	Tons.	Value.	Value per Ton.
1887	10,040	$ 23,607	$2.35
1888	5,730	11,050	1.93
1889	5,673	11,733	2.07
1890	7,110	13,850	1.95
1891	5,422	11,030	2.03
1892	6,768	9,375	1.39
1893	6,200	9,837	1.59
1894	6,469	10,264	1.59
1895	9,500	14,250	1.50
1896	7,500	11,250	1.50
1897	6,000	9,000	1.50
1898	6,160	9,240	1.50

North-west Territories.

North-west Territories.

The production of coal in the North-west Territories has increased rapidly during the last two years, the increase of 1898 over 1897 being 27 per cent., a larger percentage increase than in any of the provinces. The largest proportion of the shipments comes from the Galt mines at Lethbridge and from the mines at Anthracite and Canmore. Smaller amounts are mined in the vicinity of Edmonton and along the Souris River and at other places. Over 60 per cent of the total production is used by the Canadian Pacific Railway.

Coal.

North-west Territories.

TABLE 15.

COAL.

NORTH-WEST TERRITORIES:—PRODUCTION.

Calendar Year.	Tons.	Value.	Value per Ton.
1887	74,152	$ 157,577	$ 2.13
1888	115,124	183,354	1.59
1889	97,364	179,640	1.85
1890	128,953	198,498	1.54
1891	174,131	437,243	2.51
1892	184,370	469,930	2.55
1893	238,395	598,745	2.51
1894	199,991	488,980	2.45
1895	185,654	414,064	2.23
1896	225,868	606,891	2.69
1897	267,163	667,908	2.50
1898	340,088	825,220	2.43

British Columbia.

BRITISH COLUMBIA.

The production of coal in British Columbia is shown in Graphic Table A., and the variation in the quantity produced from year to year is easily followed. The figures for 1898 are considerably the largest and show an increase over the figures for 1897 of nearly 24 per cent. and an increase over 1891, the greatest preceding year, of over 11 per cent.

The general statistics of production for the province are shown in Table 16, the details being compiled from the report of the Minister of Mines for the province.

TABLE 16.

COAL.

BRITISH COLUMBIA :—PRODUCTION.

COAL.

British Columbia.

Calendar Year.	Output, Tons, 2,240 lbs.	Home Consumption, Tons, 2,240 lbs.	Sold for Export, Tons, 2,240 lbs. ‡	PRODUCTION.* Tons, 2,240 lbs.	PRODUCTION.* Tons, 2,000 lbs.	Price per ton, 2,240lbs.	Value.
						$	$
1836-52..	10,000				11,200	4 00	40,000
1852-59..	25,398				28,446	4 00	101,592
1859¶...	1,989				2,228	4 00	7,956
1860.....	14,247				15,957	4 00	56,988
1861.....	13,774				15,427	4 00	55,096
1862.....	18,118				20,292	4 00	72,472
1863.....	21,345	From 1836 to 1873 inclusive the output is taken as production.			23,906	4 00	85,380
1864.....	28,632				32,068	4 00	114,528
1865.....	32,819				36,757	4 00	131,276
1866.....	25,115				28,129	4 00	100,460
1867. ..	31,239				34,988	4 00	124,956
1868.....	44,005				49,286	4 00	176,020
1869.....	35,802				40,098	4 00	143,208
1870.....	29,843				33,424	4 00	119,372
1871-2-3.	148,459				166,274	4 00	593,836
1874.....	81,547	25,023	56,038	81,061	90,788	3 00	243,183
1875.....	110,145	31,252	66,392	97,644	109,361	3 00	292,932
1876.....	139,192	17,856	†122,329	140,185	157,007	3 00	420,555
1877.....	154,052	24,311	115,381	139,692	156,455	3 00	419,076
1878.. ..	170,846	26,166	164,682	190,848	213,750	3 00	572,544
1879.....	241,301	40,294	192,096	232,390	260,277	3 00	697,170
1880. ...	267,595	46,513	225,849	272,362	305,045	3 00	817,086
1881.....	228,357	40,191	189,323	229,514	257,056	3 00	688,542
1882.....	282,139	56,161	232,411	288,572	323,201	3 00	865,716
1883.....	213,299	64,786	149,567	214,353	240,075	3 00	643,059
1884. ...	394,070	87,388	306,478	393,866	441,130	3 00	1,181,598
1885.....	365,596	95,227	237,797	333,024	372,987	3 00	999,072
1886.....	326,636	85,987	249,205	335,192	375,415	3 00	1,005,576
1887.....	413,360	99,216	334,839	434,055	486,142	3 00	1,302,165
1888.....	489,301	115,953	365,714	481,667	539,467	3 00	1,445,001
1889.....	579,830	124,574	443,675	568,249	636,439	3 00	1,704,747
1890.....	678,140	177,075	508,270	685,345	767,586	3 00	2,056,035
1891.....	1,029,097	202,697	806,479	1,009,176	1,130,277	3 00	3,027,528
1892	826,335	196,223	640,579	836,802	937,218	3 00	2,510,406
1893.....	978,294	207,851	768,917	976,768	1,093,980	3 00	2,930,304
1894.....	1,012,953	165,776	827,642	993,418	1,112,628	3 00	2,980,254
1895.....	939,654	188,349	756,334	944,683	1,058,045	3 00	2,834,049
1896.....	894,882	261,984	634,238	896,222	1,003,769	3 00	2,688,666
1897.....	892,296	290,310	619,860	910,170	1,019,390	3 00	2,730,510
1898.....	1,136,015	374,953	752,863	1,127,816	1,263,154	3 00	3,383,448

* This production is obtained by adding 'Home Consumption' and 'Sold for Export.'

† 52,935 of this amount was exported as sales without the division into 'Home Consumption' and 'Sold for Export.'

‡ The figures in the 'Sold for Export' column do not agree as they should with those given in Table 5, the only explanation being that the data in the two cases are from different sources, and it has not been possible to find out the cause of the difference.

¶ Two months only.

COAL.

A large amount of British Columbia coal is exported to points on the Pacific coast of the United States, and the following figures, showing the source of California's coal supply for 1898, will be of interest in showing the position which British Columbian coal occupies in that market.

British Columbia.

Table showing source of California's coal supply for 1898 :—

	Tons of 2,000 lbs.
British Columbia	729,353
Australia	226,163
England and Wales	84,129
Scotland	5,663
Eastern (Cumberland anthracite)	42,067
Seattle (Franklin, Green River)	318,038
Carbon Hill, South Prairie, &c.	390,291
Mount Diablo, Coos Bay and Coral Hollow	193,207
Japan and Rocky Mountains	29,747
	2,018,658

THE COAL FIELDS OF CANADA.

The following short description of the coal fields of Canada will, in connection with the statistics already given, be found illustrative of the coal industry of the country. It has been compiled chiefly from information to be found throughout the Reports of the Geological Survey, supplemented by data taken from other reliable sources.

The chief fields are located as follows : In Nova Scotia there are several extensive areas of bituminous coal which have been mined for many years. In New Brunswick is a small area with thin seams, also bituminous. The above are all in rocks of Carboniferous age. In Manitoba and the North-west Territories very large tracts of the prairie country are underlain by coal beds, varying in quality from lignite in the east to bituminous in the west, as the foot-hills of the Rocky Mountains are approached. In the mountain region itself is a small basin where anthracite is mined. Across the watershed in British Columbia is the Crow's Nest Pass field now being opened up, and on the coast the areas on the east coast of Vancouver Island, that have long been worked. These coal-fields are of Cretaceous age. Coals referable to the same period are also found in the Queen Charlotte Islands and in many parts of the interior of the province. All

these Cretaceous coals are generally bituminous, but anthracite occurs in the Queen Charlotte Islands. Tertiary fuels also underlie considerable areas in the interior as well as several tracts along the coast. These are usually lignites or brown coals. COAL.

Nova Scotia.

Nova Scotia.

The coal-bearing measures of Nova Scotia belong to the Carboniferous, and are practically confined to one of its subdivisions generally known as the True Coal Measures.

The coal mined in this province is all bituminous in quality.

The following sub-divisions into fields is usually adopted :—

1. The Sydney coal field.
2. The Inverness coal field.
3. The Richmond coal field.
4. The Pictou coal field.
5. The Cumberland coal field.

Sydney Coal Field.

This field is situated in the north-east corner of Cape Breton county, and takes in a small portion of Victoria county. It occupies a land area of 200 square miles, about 32 miles long by six wide, and is limited on three sides by the Atlantic Ocean. The conditions for extraction and shipment are very favourable. There is a remarkable absence of faults and the coast affords a number of natural harbours. The greater part of the coal-field is hidden beneath the ocean, but the seams can be followed under the bed of the sea.

The measures inclosing the Cape Breton coals are largely composed of argillaceous shales and sandstones, the solidity and coherence of which favour submarine exploitation. As to the general structure, it can be said that the seams appear on the shore, sweep inland, and again enter the ocean, forming segments of ellipses whose centres are out at sea. This structure is observable at Cow Bay, Glace Bay, Lingan and Sydney, these places presenting a series of separate basins, the seams of which have been correlated, and their equivalence in many cases proved. The following tabulation, condensed from the work of the Geological Survey shows the equivalency

COAL.

of the different seams of the field at the different places together with the thickness of the intervening strata :—

Average Size.	Cow Bay.	Glace Bay.	Lingan.	Sydney Mines.	Boulardrie.
3 feet.....	....	....	Seam A	....	Point Aconi.
300 "					
6·5 "	....	....	Carr Seams...	Lloyd's Cove..	Bonar.
190 "					
12 "	....	Hub.... .	Barrasois......	Seam B.......	Stubbart.
350 "					
7 "	Block House	Harbour....	David Head ..	Sydney Main.	Seam C.
275 "					
3 "	Seam D.....	Bouthillier..	Seam D.......	Bryant.......	Mill Pond.
90 "					
4 "	Seam E.....	Back Pit....	North Head ..	Edward	Black Rock.
110 "					
7 "	McAuley...	Phelan	Lingan Main.	Seam F.......	Seam F.
125 "					
3 " ...	South Head. Spencer.....	Ross ...... Emery	Seam G	Collins	Seam G.
320 "					
4 "	Long Beach.	Gardiner ...	Seam H......	....	....

The correctness of the above correlation is, however, questioned by some miners who think that the difference in the character and size of the seams at the different places shows that they belong to separate and distinct basins. The aggregate thickness of coal in the workable beds outcropping on the shore, ranges from thirty feet at some places to sixty at others, the individual seams having thicknesses of from three to twelve feet. They dip at low angles, of five to twelve degrees, seaward, and appear to have been very little affected by disturbances. Most of the Sydney coals are well suited for the manufacture of gas, as the following figures show :—

—	Gas, Cubic Feet per Ton.	Candle Power.	Coke Produced.
Little Glace Bay	9,268	15	40 bush.
" "	9,700	14·75	39 "
International Mine.................. ...	10,000	16	1,470 lbs.
Sydney Mines..........................	8,200	8	1,295 "
Gowrie "	9,000	15	1,230 "
Caledonia "	8,900	14·25	36 bush.
Reserve "	9,950	13·17	1,500 lbs.

The value of these coals for steam and house purposes is given in the table of analyses, whenever obtainable.

The Sydney field was the first coal field opened in Canada. As early as 1785, work was done on it by the government. This, how-

ever, was of a desultory nature. In 1827, systematic and regular mining was begun by the General Mining Association. Coal.

The collieries at present in operation in this field are described below. Comparing the descriptions with the tabulation of the seams already given, it will be noted that the greater part of these are not at present under exploitation, although very extensive work has been done at different times on some of them. Should need arise, however, many of these would constitute a very important source of supply.

Sydney Mines Colliery.—Worked by the General Mining Association. Situated three miles to the north-east of North Sydney.

Main seam, 5 feet 4 inches, dip, 1 in 12.

System of working, bord and pillar.

Shaft, 13 feet diameter, 690 feet deep. A new shaft of the same diameter is now being sunk and it is expected to reach coal at a depth of 500 feet.

Hoisting engine has a capacity of 126 tons of coal per hour. Drum 18 feet in diameter. Average number of persons employed, underground 500, above ground 240.

The surface hauling plant consists of a railroad 4·8 miles in length, to the shipping piers of North Sydney, four locomotives and 200 coal cars of an average capacity of five tons.

North Sydney Colliery.—Operated by the North Sydney Mining and Transportation Co. Opened by adit 950 feet.

Surface plant consists of a semi-portable engine which hauls the coal from the mouth of the level to a bank where the coal is screened. A large and substantial wharf has been built for loading. The output is yet small; about 5,000 tons in 1897.

Cape Breton Colliery.—Operated by J. T. & J. E. Burchell. Situated at New Campbellton, on Big Bras d'Or. The colliery was first opened in 1861 and was acquired by the present owners in 1893.

Seam worked 4 feet thick, dip, 12 degrees.

Opened by slope 1,000 feet long. Worked by pillar and room system, with Ingersoll coal cutting machines.

One and a half miles of railway, narrow gauge, to shipping wharf.

Dominion Coal Company.—This company was incorporated in 1893 and controls all the remaining collieries of the Sydney field. Its output amounts to 50 per cent of the total production of Nova Scotia. It operates the collieries enumerated below:

Caledonia Colliery.—The Caledonia is situated one mile from Little Glace Bay.

COAL.

Phelan seam worked, thickness, 7 feet, with a dip of 1 in 12.

Shaft, 185 feet vertical depth, two slopes 2,300 feet and 2,500 feet respectively, main level 4,000 feet long.

Worked by both bord and pillar and long-wall methods, with coal heading and undercutting machines.

Machinery.—Pumps with aggregate capacity of 1,000 gallons per minute. Two hoisting engines. Complete plant of air-compressors for the drills and coal-cutting machines.

Underground haulage is done by endless rope, driven by horizontal engines with friction brakes.

Reserve Colliery.—Situated at Bridgeport Basin, two and a half miles from Glace Bay.

Phelan seam, 8 to 9 feet thick, dipping 1 in 14.

Worked by pillar and bord system, Two slopes, 5,000 feet long each, vertical depth 380 feet.

Machinery: Haulage and hoisting done by endless rope. Two pumping engines. Coal-cutting machinery.

International Colliery.—At Bridgeport, 12 miles from Sydney. Harbour seam worked, average thickness 5 feet 10 inches, dipping 1 in 12.

Shaft 90 feet deep and slope 4,000 feet long.

Underground haulage by endless rope. Hoisting done by a pair of engines with 8-foot drum.

Pumping done through bore hole, vertical lift 320 feet.

Old Bridgeport Colliery.—Ten miles from Sydney.

Phelan seam worked, thickness, 8 feet, average dip 1 in 11.

Shaft 120 feet. Work by pillar and bord system with coal-cutting machinery.

Haulage is done by one endless rope and one Lidgerwood engine. Hoisting, one double drum engine.

Victoria Colliery.—Situated at Low Point, south side of Sydney Harbour.

Ross seam worked, 6 feet 7 inches, dip 25 degrees.

Slope 1,740 feet and east level 4,000 feet, from the pit bottom. From this level the whole output of the mine is derived. System of working, pillar and bord.

Pumps with capacity of 270,000 gallons a day.

Hoisting engines, one pair with 7-foot drum.

Dominion No. 1.—Ten miles from Sydney. COAL.

Phelan seam worked, 8 feet, dip 1 in 14.

System of working, pillar and bord. Winning equipment consists of coal-heading machines, undercutters and one long-wall machine.

Underground haulage by endless rope. One hoisting engine, 8-foot drums and one man hoisting engine.

Surface plant consists of well equipped shops, railway siding, etc.

Besides the above-mentioned workings, the Dominion Coal Co. have erected a coal washing plant, capable of handling 500 tons a day on the Sydney and Louisburg Railway about three miles from Morien Junction. The water is obtained by gravitation from the Morrison Lakes.

Inverness Coal Field.

This comprises a series of narrow areas along a line extending from Judique to Cheticamp, on the western shore of Cape Breton Island. These areas of productive measures form parts of the rim of a basin the greater portion of which has been removed by erosion.

Seams of coal of workable size have been found at Port Hood, Mabou, Broad Cove and Chimney Corner. Attempts have been made to establish collieries at these different points; a great drawback to the development of these areas is the want of suitable harbours, affording shipping facilities, but this will soon be overcome by railway connection along the coast.

Port Hood.—At this place the strata run parallel to the shore for about two miles. One seam of seven feet has been tested, and another of about the same size is known at low water. Considerable work on the first mentioned seam was done some thirty years ago; the mine, however, has been closed down since 1878.

Mabou.—A small coal field occurs at Mabou, where the outcrops of several seams of good thickness have been noticed. The extent of the basin, however, is limited and it is much faulted. Coal has been extracted for local use.

Broad Cove and Chimney Corner.—This area is situated north of Cape Mabou. Several seams ranging in thickness from two to twelve feet have been reported. These dip seaward at an angle of about twelve degrees. The coal seems to be equal to the average of the Cape Breton coals.

Broad Cove Mine.—Operated by the Broad Cove Coal Co. This company controls four square miles of coal lands at Broad Cove, on which twelve seams have been reported.

COAL.

Four levels have been run on the larger seams. On the surface, over two miles of railway have been completed, which connect the opening with the harbour at McIsaac Lake. A channel opened between this and the gulf is so far advanced as to allow the shipment of coal. The breakwater has been strengthened, and it is contemplated to further deepen the channel so as to allow steamers of large tonnage to enter.

Chimney Corner Mines.—Operations on a large scale were carried on at this place between 1866 and 1873 on two seams. Main slope in 1872 was 400 feet down and levels driven 300 and 800 feet. Operations ceased in 1873, after a fire which destroyed the surface buildings. In 1882 the mine was reopened by Mr. Evans, but was worked a short time only.

Richmond Field.

In the south-western portion of Richmond county coal occurs in several localities, associated with the marine limestone.

Extensive explorations have been carried on in this field, and coal has been discovered at Coal Brook, Caribacon, Little River and Sea Coal Bay. Although comparatively large sums were spent between 1863 and 1878 on exploration work, very little systematic mining has been done.

Coal Brook.—At this place several seams have been reported, of the following sizes, 3 feet, 4 feet, 8 feet, and some smaller ones. The coal varies in quality from fairly good to poor and irregular.

Sea Coal Bay.—Here a seam of a thickness of about 11 feet gave on analysis such a large proportion of ash as to make it of very little use for ordinary purposes. Other seams, however, appear to be of much better quality.

In his report on this coal field, Mr. Hugh Fletcher, of the Geological Survey, gives a summary of his own observations and of information gathered from various sources.*

Pictou Coal Field.

This field situated almost in the centre of Pictou county, has an area of about 25 square miles. It is 11 miles long, with a maximum width of 3 miles between New Glasgow on the north and Stellarton on the south. The field is therefore small, but the seams are of great size, one being thirty-eight feet in thickness.

* Report of Progress, Geol. Surv. Can., 1879-80, Part F.

The district is of a remarkably intricate structure, being cut up by numerous faults of various magnitude, and the productive measures are almost completely surrounded by a girdle of faults. The field is very well situated for railway communication, which advantage, however, is somewhat offset by the physical difficulties encountered due to faulting. It has also been noticed that the seams change to a remarkable degree within short distances. The field was opened in 1798, but the first systematic work was contemporary with the development of the Cape Breton field in 1827, when both became the property of the General Mining Association. COAL.

This field is conviently divided into three districts, *viz.* :—the Central or Albion, the Western or Westville, and the Eastern or Vale.

In the Central, four seams have been worked. They are the Main, 38 feet thick, the Deep, 22 to 38 feet, the Third, 10 to 13 feet, and the McGregor, 13 to 20 feet. The measures containing these seams rest conformably on the Millstone Grit, and are overlain by 1,000 feet of shales. The dip of the coal-bearing measures varies from 10 to over 30 degrees. Several other seams have been reported in this section, but none of workable size.

The Westville section is separated from the Albion section by a downthrow fault, estimated at from 1,600 to 2,600 feet. Three seams of this section are believed to be equivalent to some of the Albion section. The variation in dip and change of character in short distances are similar in both sections.

The Vale section is different in character. It is in the form of a syncline with east-and-west axes. The thicker and more valuable seams appear in the southern outcrop, where they are worked, On the northern side they thin out. Two seams of this section, *viz.*, the McBean and the Six Foot have been extensively worked.

The companies now at work exploiting the Pictou field are as follows :—

Acadia Collieries.—Operated by the Acadia Coal Co. Situated at Westville, 3 miles from Stellarton.

Seam worked 10 feet, with an average dip of 27 degrees.

Opened by one slope 3,900 feet long, vertical depth, 1,700 feet. Worked in lifts of 300 feet, long-wall with timber packs.

Pumping and haulage by compressed air. Hoisting engine in slope 32-inch cylinders, 10-foot drums.

Albion Colliery.—Operated by the Acadia Coal Co. Situated at Stellarton on the I. C. R.

Coal.

Four seams have been opened—Deep seam, Main seam, Third seam and McGregor seam.

Worked by both long-wall and pillar and bord.

Drummond Colliery.—Operated by the Intercolonial Coal Mining Co. Situated at Westville.

Seams opened, Main and Second.

Worked by pillar and bord method; no explosives used, the coal being all mined by maul and wedge. The seam is reached by slopes 12 x 8 feet.

Winding engine in No. 1 slope has a pair of cylinders 28 inches, a pair of drums 10-feet diameter. In No. 2 slope, winding engine cylinders 16 inches, drums 8 feet.

The mine is connected by railway 7 miles in length with a wharf at Granton at which ships of large tonnage can load. The railway is owned by the company.

Vale Colliery.—Operated by the Acadia Coal Co. Situated six miles east of New Glasgow.

Seams worked, McBean and Six Foot. On the McBean seam a slope has been driven 3,100 feet long, vertical depth 1,600 feet, dipping 14 to 35 degrees. Work on this seam has been suspended. On the Six Foot seam a slope 2,400 feet has been driven, and work is going on in a systematic and steady way.

The mines of the Pictou field being fiery, very complete ventilation plants have been established at all the colleries, and safety lamps are used everywhere.

Cumberland Field.

This is the most westerly of the coal districts of Nova Scotia, a part of it being adjacent to Chignecto Bay.

In this field there are two coal producing areas. One situated near the coast, which may be called the Joggins coal basin, and the other situated about 15 miles to the east of the first, at Springhill. The equivalence of the seams in these two basins has not yet been determined. So far as known at present, the two basins do not appear to be connected. It must be said, however, that owing to the present known fields being adequate to the demand, but little search for coal has been made between the above-mentioned areas, exploration being rendered difficult in any case by the presence of brush and soil covering.

In the Joggins area the following seams of workable size are known. At Joggins two seams, respectively 4 and 6 feet. At the River Hebert

one 5-foot seam with two shale partings. At Maccan two seams, the upper $2\frac{1}{2}$ and the lower $4\frac{1}{2}$ feet. At Chignecto a seam of $9\frac{1}{2}$ feet of which $2\frac{1}{2}$ feet are shale partings. COAL.

The Joggins Colliery.—This is an important producer. It is operated by the Canada Coals and Railway Co. and is situated 11 miles from Maccan Station, on the Intercolonial Railway. A branch of standard gauge connects the two points. The colliery is also connected with Joggins wharf by a tramway one and a half miles long.

The seam worked shows 4 to 5 feet of coal with a clay parting in the centre, from 1 to 3 feet, making a total thickness worked of 6 to 8 feet. Dip 17 degrees. Opened by two slopes, 2,700 and 1,900 feet respectively, which are now connected. System of working, long-wall. Haulage is done by tail rope system. Good equipment of winding engines. Number of men employed: underground 150, surface 55.

Several of the other seams have been opened and worked, some to an important extent. At present three or four other collieries are producing in a desultory way.

Springhill Basin.—Eight seams have been recognized in this basin, occurring in the following order:

	Feet.	Inches.
Coal	13	0
Strata	105	0
Coal	6	0
Strata	130	0
Coal	2	4
Strata	185	0
Coal (main seam)	11	0
Strata	90	0
Coal (S. seam)	11	0
Strata	100	0
Coal	2	6
Strata	190	0
Coal	4	0
Strata	176	0
Coal	2	9

The seams of this basin are fiery, and great care is taken to use no explosives. All lamps are safety lamps. All operations are carried on by the Cumberland Railway and Coal Company by three slopes as follows:—

No. 1 Slope.—Seam worked 8 feet. Dip 30 degrees, slope 2,600 feet long.

COAL.

Worked by pillar and bord method.

Underground haulage. Tail rope system—by one pair-link reversing geared haulage engine, with four drums 5 feet in diameter.

No. 2 Slope. Seam $10\frac{1}{2}$ feet thick, dip 30 degrees, slope 3,000 feet long.

Worked by pillar and bord.

Same system of underground haulage as in No. 1 slope.

No. 3 slope.—Seam worked 10 feet thick, dip 28 degrees, slope 2,600 feet long.

System of working, long-wall and bord and pillar.

Underground haulage, tail rope.

Marsaut's safety lamps are exclusively used.

NEW BRUNSWICK.

The only known coal field of economic value in New Brunswick is that situated at the head of Grand Lake, Queen's county. Outcrops of coal in this area have been worked to a limited extent since 1825.

The area underlain by productive coal-measures in this field is about 100 square miles. The coal is of good quality but the seams are thin. With the hope of proving the existence of thick seams in this area, borings have been made at different times, but without attaining the object in view. The usual thickness of the seams is 15 to 20 inches, The total quantity of coal in this district has been estimated at from 100 to 150 million tons.

Although mining operations were begun more than fifty years ago, they are yet conducted in a small way, and the proximity of the Nova Scotia fields, as well as the limited thickness of the seams would hardly justify the expenditure necessary for exploitation on a large scale. The beds are flat, lying with a cover varying from 2 to 30 feet, rendering it possible in many places to work them opencast. This enables small seams to be worked profitably for the local market, when the stripping does not exceed 8 feet. Beyond this depth it would be more advantageous to work under ground.

MANITOBA AND NORTH-WEST TERRITORIES.

In Manitoba and the North-west Territories the coal measures occur in the Cretaceous system, or in the Laramie, which may be regarded as its upward continuation. The coals grade from lignite or

brown coal, to anthracite, according to the amount of alteration they have undergone. COAL.

Several coal-bearing districts or basins have been recognized throughout this region, and in the majority of these some work has been done, either of a prospecting nature or for local wants, while in three of these districts, coal seams are systematically worked and extensive and well equipped collieries have been opened on them.

Souris River Coal Field.

This field is situated in Assiniboia, near the United States boundary, between the 102nd and 103rd meridans.

The product of the field is lignite coal. It is exploited by two companies.

Roche Percée Colliery Co.—Operates a mine on Section 34 Township 1, Range 6, west of the 2d. meridian, near Estevan. The seam at present worked is 9 feet thick. Mining is done by drifting, the entries being made from the face of the cliffs forming the sides of Souris valley. No shafts are necessary.

The company has built its own railway, one and one-eighth miles long, to connect with the Canadian Pacific Railway at Roche Percée station. The product is marketed at Winnipeg and Regina.

Souris Coal Mining Co.'s Colliery.—This is situated on Section 4, Township 2, Range 6, west of the 2d meridian.

This property is underlain by the same seam that is worked by the Roche Percée Co. and the same remarks apply to the exploitation. The company has built a railway from its mine to Roche Percée station, a distance of one mile and three-quarters.

Belly River Coal Field.

This field is situated in Alberta, North-west Territories. This area is on the 113th meridian, south of the 50th degree of latitude.

The fuel of this basin is good lignite-coal. It finds a ready market in Manitoba, North-west Territories, as well as in the United States.

Lethbridge Collieries.—Situated at Lethbridge, Alberta District. Operated by the Alberta Railway and Coal Co.

Seam worked 4 feet 8 inches thick, with a thin clay parting 2 feet from the roof. Worked by pillar and stall method.

COAL.

The seam is reached by three shafts, 300 feet deep, and half a mile apart. Worked with coal-cutting machines. With the present equipment an output of 1,000 tons a day could be attained.

The surface plant consists of extensive shops, good winding and ventilation machinery, etc. The company also owns 200 miles of railway, with equipment, from Lethbridge to Great Falls, Montana.

Cascade Coal Basin.—This is part of the Bow River Valley, which is underlain by Cretaceous coal-bearing rocks. It forms a basin or trough, running from longitude 113, latitude 51, in a north-westerly direction. It has a length of 30 miles and a total area of 60 square miles. This area although small contains much coal.

Some of the seams have been locally converted to anthracite, although most of them are bituminous.

At 'Marsh's mine,' near the south end of the field, are two seams, one about 15 feet and the other 8 feet. Three miles to the north-west of this, are several openings into beds of workable size. At Canmore there are three seams of 4 feet, 12 feet and 16 feet respectively. At Anthracite three seams are now being worked, two of a thickness of 4 feet each and one of 3 feet. All of these seams are situated very near the main line of the Canadian Pacific Railway.

The measures in this field are often faulted, and the seams dip to the south-west at an inclination varying from 15 to 60 degrees. At Canmore two of the seams are almost vertical. The field was first opened by the Canadian Anthracite Coal Co., in 1886, at Canmore and Anthracite.

Canadian Anthracite Coal Co.'s Collieries.—These two colleries, one at Canmore and the other at Anthracite, are situated on the line of the Canadian Pacific Railway. The property was leased to H. W. McNeil Co. in 1891 for a period of ten years, and it is this latter company which at present works them.

At Anthracite the product is a hard coal for house use. The mining capacity of this colliery is 150 tons per day. At Canmore the coal is bituminous and is suitable for locomotive use. The mine is equipped for an output of about 600 tons per day.

Pillar and stall is the method of extraction followed. Safety lamps are used exclusively in both collieries.

BRITISH COLUMBIA.

In western Canada coal occurs in connection with newer rocks than in the east. Although Carboniferous rocks of great thickness are frequently met with in the west, they are all marine deposits, mainly

limestones. Swamps and marshes which afford the conditions giving rise to accumulation of vegetable matter, producing coal beds, existed in the Cretaceous and Tertiary times. In character the coals of British Columbia range from anthracite to lignite, showing that the grade depends on conditions of metamorphism rather than on age. COAL.

Four recognized coal-fields may be named, but mineral fuels are known in many other places, which have only to be worked in order to receive recognition.

The Crow's Nest Pass Field.
The Nanaimo Field.
The Comox Field.
The Queen Charlotte Islands Field.

The Crow's Nest Pass Field.

This is the most easterly of those mentioned. Although very important as to area and quality of coal, it had only recently become available by the construction of the Canadian Pacific Railway, which traverses it and permits its product to be delivered at the smelting centres of the Kootenay districts at lower rates. Development work has been carried on rapidly and some coal was shipped during 1898.

These coals were first described by Dr. G. M. Dawson in the annual report of the Geological Survey of Canada for 1885. In his report on the Mineral Wealth of British Columbia (Annual Report, Geol. Surv. Can., 1887–88), he describes the field as follows :—

'The Cretaceous basin or trough in which it occurs is somewhat extensive and resembles in general character those which occur on the opposite side of the Rocky Mountains watershed, beyond the limits of British Columbia, in one of which the Cascade anthracite is included. The age of those Cretaceous rocks appears to be nearly the same with that of those of the Queen Charlotte Islands. By the prospecting work which has lately been executed in the Crow's Nest Pass, the existence of no less than fifteen workable seams is said to have been determined, two of which are reported as 14 and 30 feet, respectively, in thickness.'

In his summary report for 1891, Dr. Selwyn also draws attention to the importance of this field and enumerates the coal-seams discovered up to that time.

Crow's Nest Pass Coal Co.—This Company has its colliery at Coal Creek. It is connected by a branch line with the Crow's Nest Pass Railway of the Canadian Pacific system The company was incorporated

COAL.

in April, 1897, and since then the work of opening up and installing the colliery on a thorough basis has been pushed very actively.

Seams worked : On the north side of Coal Creek, a seam of bituminous coal 6 feet in thickness. On the south side of the Creek, a seam of semi-anthracite coal $6\frac{1}{2}$ feet thick, both dipping 5 to 10 degrees. It is intended to so erect the surface plant that both seams can be worked simultaneously.

Method of working : pillar and stall with electrical coal-cutting machines. Haulage is done by electrical locomotives ; the steam plant used is to be superseded. It is intended to utilize water power to generate electricity, which will be used for all purposes.

Nanaimo Coal Field.

This field is situated on the island of Vancouver, in the south-eastern part. Its area has been estimated at about 200 square miles. Two seams, at least, of workable thickness are known but the measures being much folded and cut up by faults, it is very difficult to correlate the beds in the various parts of the field.

The product of both this and the Comox areas is largely exported to California where it competes successfully with the coals produced in the United States although handicapped by an import duty.

New Vancouver Coal Mining and Land Co.—This Company was organized in 1862 and reconstructed in 1889. It operates the Nanaimo collieries, which consist of the following :

Northfield Colliery.—Situated four miles from Departure Bay. Seam worked 2 to $3\frac{1}{2}$ feet thick ; dip, 6 degrees ; worked by shaft 440 feet deep, and slope at bottom 2,100 feet. System of working, long-wall. This colliery is at present idle.

No. 1 Esplanade.—Situated half a mile from the wharfs of Nanaimo harbour.

Seam worked the 'Harbour'; thickness, 5 to 12 feet; dip, 6 degrees; shaft, 650 feet deep. System of working, pillar and stall.

Haulage.—For haulage from the levels, which are in about 2 miles from the foot of the shaft, the company uses electric motors.

Ventilation by Guibal fan, 36 feet in diameter and 12 feet wide. Connected with the Protection Island shaft which is used as intake.

Lamps, naked lights.

The workings of this extensive colliery are under the waters of Nanaimo harbour and beneath the surface of Protection Island. The mine is quite safe from invasion by water, being protected by a thickness of rock and earth varying from 400 to 1,200 feet between the

workings and the bed of the harbour. The pillars left in place amount to two-thirds of the original seam, this large proportion being thought necessary to insure safety. They will be robbed at a later period. COAL.

Protection Island Shaft.—Situated 300 yards from the shipping wharf and half a mile from Nanaimo.

Seams worked, the 'Douglass,' upper and lower. Thickness of upper seam 6 to 8 feet; dip 6 degrees, vertical depth of shaft to seam 670 feet. The lower seam is reached at a depth of 740 feet and is 4 feet thick.

In the upper seam two slopes have been driven, 900 and 600 yards respectively.

System of working, pillar and stall.

Ventilation.—This shaft is the intake of the system of ventilation which takes in Esplanade shaft.

Southfield Colliery.—No. 5. Situated five miles from Nanaimo in the southern part of the area controlled by the New Vancouver Coal and Mining Co.

Seam worked varies from 6 to 12 feet in thickness. Dip 6 degrees. Vertical depth of shaft 508 feet.

System of working, pillar and stall.

This part of the field is very much cut up by faults and breaks.

The New Vancouver Coal Co. also employ a large staff for the purpose of prospecting, both with pick and with the diamond drill.

Wellington Collieries.—These collieries are owned and operated by Messrs. Dunsmuir and Sons. They are situated in North Nanaimo, six miles from the city of Nanaimo.

Seam worked is the 'Wellington.' The workings consist of six shafts numbered 1 to 6 Wellington.

Shafts Nos. 1 and 5 are connected, as are also Nos. 3 and 4.

Ventilation by fan.

Shafts Nos. 5 and 6 are the most important producers. The method of working is, in No. 5 pillar and stall, and in No. 6 both pillar and long-wall.

The fire-clay which constituted the original soil on which grew the coal-forming vegetation is mined along with the coal and finds a ready market.

The surface plant and rolling stock consist of five miles of railway with sidings and branches, six locomotives, and 250 coal cars; 13 stationary engines, 9 steam pumps, also wharfs and accommodations for loading vessels, &c.

COAL.

The number of persons employed in the collieries in 1897 was nearly 800.

Alexandria Colliery.—This is also owned and operated by Messrs. Dunsmuir and Sons.

It is worked by a slope 800 yards long, with a tunnel off the slope, also 800 yards.

Force employed is about 30, for an output of about 120 tons a day.

Ventilation is effected by a furnace in the upcast shaft.

West Wellington Colliery.—This is owned and operated by the West Wellington Coal Co.

Seam worked West Wellington, 4 to 6 feet, opened by a slope and two levels, which are worked. Also a separate outlet for ventilation.

Comox Field.

This field is situated on the north-west of the Nanaimo field from which it is separated by the intervention of crystalline rocks. The Comox area has probably a greater extent of productive measures than the Nanaimo field. Mr. Richardson, late of the Geological Survey, estimated it at 300 square miles, without taking into consideration the seaward extension.

In a section on Brown River almost the entire thickness of the productive measures is exposed, amounting to 740 feet. In this section nine seams occur, with an aggregate thickness of 16¼ feet. At the Union mines a section of 122 feet reveals ten seams aggregating to 29¼ feet, the thickest being 10 feet.

Union Colliery Co., of British Columbia.—This company operates the Union Colliery, near Comox.

Seams worked, thickness 3 and 5 feet, dip 1 in 6 north. Opened by two slopes and one shaft, called respectively, No. 2 slope, down 700 yards, No. 4 slope, 2,400 yards, and No. 5 shaft, 600 feet deep.

System of working: upper seam, long-wall method; lower seam, pillar and stall.

The colliery is connected with the shipping wharf by 11 miles of standard gauge road. The rolling stock includes four locomotives and 120 cars. Force employed, about 750.

Queen Charlotte Island Field.

This field is in that part of the Cretaceous area of the province which extends over parts of Graham and Moresby Islands, on both sides of Skidegate Sound.

The coals are anthracite and bituminous, the former comparing favourably with that of Pennsylvania. In the 'Mineral Wealth of British Columbia' Dr. Dawson speaks of the Cowgitz seams on the Skidegate as follows : Coal.

'At Cowgitz, the Queen Charlotte Coal Mining Co. about 1871 constructed a wharf, houses, tramway, &c., and attempted to work the coal seams which have there the character of anthracite, but met with difficulties in following the seams, of which some portions were found to be in a crushed and pulverulent state.

'(Though these efforts were not attended with success, the work was not carried far enough to prove that the coal in this vicinity is not of a workable character. Further exploration appears to be fully justified by what is known of the place * * * The beds containing the anthracite are almost vertical, and it is evidently on account of the disturbance and local alteration which it has suffered that the coal has passed into the condition of anthracite. The best seam found had a maximum thickness of a little over 6 feet, while a second outcrop showed 2 feet 5 inches.'

A bed 18 feet thick, of bituminous coal, has been reported on the Ya-Kum River, midway between Skidegate and the head of Masset Inlet.

Means of communication with the coast, however, must be provided for before this deposit can be utilized.

COKE.

The production of coke in 1897 and 1898 was as follows :— Coke.

Province.	1897.		1898.	
	Tons.	Value.	Tons.	Value.
		$		$
Nova Scotia	41,532	90,950	48,400	111,000
British Columbia............	19,154	85,507	39,200	175,000
Totals	60,686	176,457	87,600	286,000

The increase of 1898 over 1897 was 26,914 tons or 44 per cent and in value $109 543 or 62 per cent being due chiefly to the greatly

Coal.

increased output in British Columbia. The value of coke in British Columbia is much greater than in Nova Scotia being about $5 per long ton at the mines in the former province and from $2 to $3 in the latter. Hence with the production increasing more rapidly in British Columbia than in Nova Scotia the total value increases at a greater rate per cent than the quantity.

Coke.

Production.

The annual production since 1886 is shown in Table 1 below :—

Table 1.

Coke.

Annual Production.

Calendar Year.	Tons.	Value.	Value per Ton.
1886	35,396	$101,940	$2.88
1887	40,428	135,951	3.36
1888	45,373	134,181	2.96
1889	54,539	155,043	2.84
1890	56,450	166,298	2.95
1891	57,084	175,592	3.08
1892	56,135	160,249	2.85
1893	61,078	161,790	2.65
1894	58,044	148,551	2.56
1895	53,356	143,047	2.68
1896	49,619	110,257	2.22
1897	60,686	176,457	2.91
1898	87,600	286,000	3.26

Prior to 1893 this was entirely the production of Nova Scotia and from 1893 to 1896 but very small quantities were manufactured in British Columbia. In the former province the coke is used chiefly in the iron and steel furnaces, while in British Columbia it is used largely for smelting the ores of gold, copper, silver, lead, &c., in West Kootenay District and is also being exported to adjacent portions of the United States.

The Union Colliery Company has now two batteries of beehive ovens of 100 ovens each, the second battery having been completed during the year. The Crow's Nest Pass Coal Company have thirty beehive coke ovens in operation at Fernie with others in progress.

Coal.

The imports of coke are shown in Tables 2 and 3, below :—

Coke.

Imports.

TABLE 2.

COKE.

IMPORTS OF OVEN COKE.

Fiscal Year.	Tons.	Value.
1880	3,837	$ 19,353
1881	5,492	26,123
1882	8,157	36,670
1883	8,943	38,588
1884	11,207	44,518
1885	11,564	41,391
1886	11,858	39,756
1887	15,110	56,222
1888	25,487	102,334
1889	29,557	91,902
1890	36,564	133,344
1891	38,533	177,605
1892	43,499	194,429
1893	41,821	156,277
1894	42,864	176,996
1895	43,235	149,434
1896	61,612	203,826
1897	83,330	267,540
1898.......Duty free	135,060	347,040

TABLE 3.

COKE.

IMPORTS OF OVEN COKE—FISCAL YEARS 1897 AND 1898.

Province.	1897.		1898.	
	Tons.	Value.	Tons.	Value.
		$		$
New Brunswick	13	130	9	26
Quebec	7,526	26,496	10,226	35,001
Ontario	60,255	160,367	122,246	298,904
Manitoba	186	1,163	284	1,389
British Columbia	15,350	79,384	2,295	11,720
Total	83,330	267,540	135,060	347,040

The increase of the imports in 1898 over those in 1897 was 51,730 tons or over 62 per cent. Ontario was the chief importing province, one of the largest consumers being the Hamilton Blast Furnace Company at Hamilton. It will be noticed also that the imports into British Columbia have diminished considerably, the home product having taken the place of the imported article.

COAL.

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ANALYSES OF CANADIAN COALS.

SYDNEY FIELD, N.S.

Seam or Mine.	Fast or slow coking.	Moisture.	Vol. Matter.	Fixed Carbon.	Ash.	Sulphur.	Spec. Gravity.	Theor. Evap. Power.	*Analyst.	†Reference.
		p. c.	p. c.	p. c.	p. c.	p. c.				
Hub seam	......	......	29·10	65·50	4·50	3·29	......	......	*g*	C
"	......	......	28·62	68·14	3·24	2·29	......	8·59	*k*	D
Block House seam	S	·600	29·48	65·57	4·35	2·63	1·292	8·97	*a*	A
"	......	......	31·94	62·79	5·27	3·76	......	7·67	*k*	D
Habour seam	S	·80	27·85	67·05	4·30	2·32	1·29	9·19	*a*	A
" Internat. Coll	......	......	34·09	62·92	2·99	2·26	......	7·76	*k*	B
" Glace Bay	......	......	30·21	67·78	2·01	·90	......	9·31	*k*	D
"	......	......	37·96	54·84	5·60	4·03	......	......	*g*	C
Victoria seam	S	·28	28·61	67·61	3·50	2·84	1·29	9·27	*a*	A
"	......	......	38·70	58·40	2·90	......	......	8·02	*b*	D
Sydney main	S	3·04	31·14	61·50	4·32	1·24	1·30	8·45	*e*	B
"	......	3·13	23·81	67·57	5·49	......	......	9·25	......	E
Sydney Colliery	S	1·26	33·84	60·79	4·12	1·71	1·312	8·33	*a*	A
"	......	......	32·74	61·54	5·72	3·37	......	8·49	*k*	B
McAuley seam, Gowrie mine	......	......	36·25	58·05	5·70	2·34	......	7·97	*p*	D
Gowrie Colliery	S	·50	28·13	66·01	5·36	2·71	1·31	9·05	*a*	A
Phelan seam, Caledonia Coll	S	·92	28·63	64·02	6·43	1·11	1·33	8·78	*a*	A
" "	......	......	33·00	57·37	9·63	......	......	7·88	*d*	B
" "	......	......	28·02	68·05	2·19	1·72	......	......	*g*	C
" Reserve Coll	......	......	32·00	63·93	2·95	1·33	......	......	*g*	C
" "	......	......	37·26	58·39	4·35	2·06	......	8·02	*r*	B
" "	......	1·00	36·26	......	4·35	2·47	......	......	*r*	B
" "	......	......	34·50	59·50	6·00	......	......	......	*s*	B
" "	......	·52	34·21	59·73	5·54	1·25	1·28	8·19	*a*	A
" Dominion Coll	......	......	25·13	71·22	2·73	1·10	......	......	*g*	C

Coal.

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" Old Bridgeport	......	......	31·81	63·86	3·09	1·33	......	......	*g*	C
" Clyde Coll	......	......	32·82	64·33	2·85	2·17	......	7·88	*k*	D
Lingan seam	S	·75	34·61	61·39	3·25	1·35	1·29	8·42	*a*	A
"	......	......	30·03	66·90	3·07	·77	......	9·07	*c*	D
South Head seam	S	1·77	28·00	62·26	7·97	2·64	1·38	8·53	*a*	A
Emery seam	S	·65	32·21	63·49	3·65	2·41	1·29	8·70	*a*	A
Ross seam, Schooner Pt	......	......	38·10	58·46	3·44	1·21	......	8·03	*r*	B
Collins seam	S	1·98	26·16	66·48	5·40	2·25	1·311	9·10	*a*	A
Gardiner seam	S	......	31·96	65·22	2·82	1·18	......	......	*k*	B
"	......	......	34·33	61·97	3·70	......	......	8·51	*b*	D
Lorway seam	......	......	34·84	55·98	13·28	6·27	......	8·02	*k*	D
Traccy seam	......	2·23	30·09	66·61	·98	......	......	......	......	B
Fraser seam	......	......	31·40	62·40	6·20	......	......	......	......	B
Carroll seam	......	......	32·80	61·40	5·80	......	......	......	......	B
Block House seam	......	......	38·80	55·80	5·40	......	......	7·67	*d*	B

INVERNESS FIELD, N.S.

Chimney Corner	F	8·19	26·39	57·70	7·72	......	......	......	......	A
Broad Cove, 7-foot seam	S	4·02	20·17	70·41	5·40	......	......	......	*c*	A
"	S	7·24	25·75	56·86	10·15	1·41	......	7·61	*t*	A
" 5-foot seam	S	7·78	27·67	52·87	11·68	......	......	......	*a*	E
" 4 "	S	8·45	28·36	56·94	6·25	......	......	......	......	E
Port Hood	S	2·54	29·82	61·93	5·73	5·54	......	8·49	......	A
" 7-foot seam	S	4·02	34·86	53·60	7·52	......	......	......	*a*	E

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t Geological Survey of Canada Laboratory.

Coal.

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ANALYSES OF CANADIAN COALS—*Continued.*

RICHMOND FIELD, N.S.

Seam or Mine.	Fast or slow coking.	Moisture.	Vol. Matter.	Fixed Carbon.	Ash.	Sulphur.	Spec. Grav.	Theor. Evap. Power.	*Analyst.	†Reference.
		p. c.	p. c.	p. c.	p. c.	p. c.				
Sea Coal Bay, 11-foot seam	....	....	25·20	44·70	30·10	....	....	....	*b*	A
Little River, 4-foot seam	....	....	30·25	56·10	13·25	....	....	....	*b*	A

PICTOU FIELD, N.S.

Seam or Mine.	Fast or slow coking.	Moisture.	Vol. Matter.	Fixed Carbon.	Ash.	Sulphur.	Spec. Grav.	Theor. Evap. Power.	*Analyst.	†Reference.
Main seam, average of 31 analyses*	S	....	23·65	62·61	13·61	....	....	....	*b*	B
" Ford pit	....	1·48	24·28	66·50	7·74	·55	1·294	9·13	*c*	B
Albion Mines	S	1·05	26·19	63·41	9·35	1·48	1·31	8·68	*a*	A
Acadia Coal Co.—McGregor pit, slack	S	1·50	26·80	58·90	13·70	1·73	....	....	*m*	F
" " Ford pit	....	1·50	25·90	54·30	18·30	·73	....	....	*m*	F
Acadia Colliery	S	2·10	32·27	57·57	7·55	·51	1·320	....	*d*	B
Drummond Colliery—Top coal	....	·72	29·93	60·35	9·46	·26	1·309	8·29	*d*	B
" " Fall coal	....	1·56	31·69	60·32	7·56	·43	1·328	8·29	*d*	B
" " 1st bench	....	1·80	33·53	55·39	10·50	·58	1·327	7·61	*d*	B
" " 2nd "	....	1·31	29·97	60·31	8·67	1·05	1·343	8·29	*d*	B
" " 3rd "	....	1·43	30·76	59·89	8·79	·564	1·335	8·27	*d*	B
" " Coarse bench	....	1·58	32·81	37·16	31·03	....	1·765	....	*d*	B
Deep seam	S	·75	20·31	68·50	10·41	·945	1·330	9·39	*a*	A
"	S	1·30	25·44	61·65	10·25	·861	1·330	....	*d*	B
"	....	2·54	20·46	68·50	8·50	1·69	1·345	9·41	*e*	B

McGregor seam			22·50	65·70	11·80		1·334	9·03		B
"			23·30	70·00	6·70		1·301	9·62		B
Intercolonial Mine	S	1·52	29·46	60·19	9·10	1 625	1·330	8·24	*a*	A
Montreal and Pictou Mines		4·40	24·95	61·07	9·58			8·39	*c*	B
" " "		5·47	19·93	68·55	6·05		1·360	9·41	*c*	B
McBean seam, east side of East River		1·57	29·29	52·36	16·76				*f*	B
"		2·67	28·65	49·66	19·42				*f*	B
"		2·67	27·20	54·86	15·27				*f*	B
"		1·94	23·95	57·17	16·94				*f*	B
"	S	·86	20·95	64·95	13·24	·85		8·90	*a*	A
McKay seam, north part	S	1·62	22·86	68·18	7·34	·53		9·35	*a*	A
" south "		·90	22·50	65·28	11·32	1·72		8·97	*a*	A
"		None.	29·72	62·28	8·00					B
"		None.	29·98	62·15	7·87					B
Richardson seam		·76	38·84	55·81	5·09					B
Greener	S	1·22	22·96	65·61	10 21	Trace.		8·99	*a*	A
Pottery		·57	19·24	72·76	7·43	·65		9·97	*a*	A

* Average of samples taken every foot across the section of the seam.

CUMBERLAND FIELD, N.S.

Joggins	S	2·50	36·30	56·00	5·00				*a*	A
Maccan	S		37·00	59·17	3·83				*a*	A
Styles	S	4·05	33·72	55·83	6·40				*a*	A
"	S	3·72	33·24	52·15	10·89				*a*	A
Springhill—Main seam, 11 feet—										
Band No. 1	S	·98	30·84	60 73	7·45	·85	1·31	8·33	*a*	A
" No. 2	S	·76	32·22	60·91	6·11	·56	1·30	8·40	*a*	A
" No. 3	S	1·21	33·81	63·13	1·85	·79	1·28	8·65	*a*	A
" No. 4	S	·30	29·19	67·95	2·56	1·21	1·27	9·28	*a*	A
" No. 5	S	·63	28·90	65·16	5·31	1·85	1·29	8·92	*a*	A
" No. 6	S	·90	34·56	60·59	3·95	·89	1·28	8·32	*a*	A
" No. 7	S	1·34	33·64	59·86	5·16	1·40	1·29	8·20	*a*	A
" No. 8	S	·56	30·27	60·89	8·28	2·65	1·33	8·35	*a*	A
" No. 9	S	·41	28 54	63·63	7·42	2·25	1·32	8·99	*a*	A

*, † See page 57 s.

Coal. Analyses.

COAL.

Analyses.

ANALYSES OF CANADIAN COALS—*Continued.*

NORTH-WEST TERRITORIES.

Locality.	Fast or slow coking.	Moisture.	Vol. Matter.	Fixed Carbon.	Ash.	Sulphur.	Spec. Gravity.	Theor. Evap. Power.	* Analyst.	† Reference.
LIGNITES.		p. c.	p. c.	p. c.	p. c.	p. c.				
Souris River, 7 miles from Roche Percée, seam 6 feet	....	17·78	29·51	44·36	8·35	....	....	....	....	....
La Roche Percée, seam 5 feet	S	21·84	32·15	41·61	4·40	....	1·417	....	*t*	B
South Saskatchewan, 10 miles above Medicine Hat, seam 4 feet	S	16·82	29·54	46·34	7·30	....	1·397	9·57	*t*	B
" " "	S	17·70	28·63	49·83	3·84	....	1·372	....	*t*	B
South Saskatchewan, 7 miles from Medicine Hat	....	19·90	30·88	44·03	5·19	....	....	....	*t*	B
North Saskatchewan, 40 miles below confluence of Brazeau River, seam 18 to 20 feet	S	14·78	28·46	58·69	6·07	....	1·434	9·84	*t*	B
North Saskatchewan, below Fort Edmonton, seam 6 feet.	S	12·89	32·19	52·17	2·75	....	1·426	9·69	*t*	B
" 1½ miles below ferry at Edmonton, Alta., seam 4 feet	....	11·47	36·12	48 57	3·84	....	....	....	....	....
Red Deer River, mouth of Arrowood, 6-foot seam	S	13·08	31·49	51·35	4·08	....	1·403	9·95	*t*	B
" 2 miles below Arrowood, 5 feet	S	14·20	30·92	51·21	3·67	....	1·393	....	*t*	B
" 7 miles above Hunter's Hills, 3½ feet	S	13·06	29·41	48·51	9·02	....	1·426	9·36	*t*	B
" 9 " " 1½ "	S	13·63	31·31	41·81	13·25	....	....	....	*t*	B
" 13 " " 1¼ "	S	12·62	32·08	46·72	8·58	....	1·422	....	*t*	B
" Tp. 38, R. 24, W. 4th M., seam 10 feet	....	7·66	25·90	34·53	31·91	....	....	....	*t*	B
Bow River, Grassy Island, seam 4½ feet	S	11·90	31·20	50·97	5·93	....	1·416	10·19	*t*	B
" Blackfoot Crossing, 3 feet	S	11·91	30·04	54·78	3·27	....	1·397	10·29	*t*	B
" 4 miles below Blackfoot Crossing	S	10·72	29·26	46·09	13·93	....	....	....	*t*	B
" Crowfoot Creek, seam 6 feet	S	11·25	31·98	50·85	5·92	....	....	....	*t*	B
" Horseshoe Bend, seam 4½ feet	S	11·13	36·52	43·16	9·19	....	....	....	*t*	B
Crowfoot Creek, 5 miles from Bow River, Sec. 7, Tp. 22, Range xx, west of 4th M., 9 feet	F	10·35	30·97	43·04	15·64	....	....	....	*t*	B

Belly River, 5 miles below Little Bow River	S	9·18	30·66	53·31	6·85	....	1·398	10·84		B
" coal banks, seam 5½	S	6·50	31·59	54·36	7·55	....	1·359	11·51	*t*	B
St. Mary River, 7 miles above junction with Belly River	S	7·02	29·41	57·28	6·29	....	1·369	11·72	*t*	B
Yukon District, 7 miles up Coal Creek, seam 12½ feet	F	7·24	41·45	48·91	2·40	....	....	....	*t*	B
COALS.										
Cascade River, 2¾ miles from confluence with Bow River, seam 20 inches	S	2·07	15·84	74·35	7·74	....	....	....	*t*	B
Cascade River, semi-anthracite, seam 3 feet 10 inches, ¼ mile from C.P.R.	F	1·04	9·15	87·18	2·63	....	....	....	*t*	B
Bow River, Coal Creek seam 4½ feet	S	4·93	27·22	52·54	15·31	....	1·400	10·93	*t*	B
Bow River Pass seam 4 feet	S	·71	10·58	81·14	7·57	....	1·427	14·62	*t*	B
Coal Creek, Bow River, Sec. 22, Tp. 27, R. 5, west of 5th M.	F	2·79	36·90	53·40	6·91	....	....	....	*t*	B
Marsh's Mine, ½ mile south of Bow River at Gap Siding, 2 seams, 10 and 12 feet	....	·70	11·03	79·78	8·49	....	....	....	*t*	B
Little Red Deer River, 11-foot seam; foot-hills at base of main limestone range of Rocky Mountains	F	1·87	13·74	79·55	4·84	....	....	....	*t*	B
Little Red Deer River, seam 4 feet	F	1·52	11·65	81·16	5·67	....	....	....	*t*	B
Sheep Creek, Sec. 2, Tp. 20, R. 3, west of 5th M., 4-foot seam	F	3·08	39·37	54·50	3·05	....	....	....	*t*	B
Near Moose Mountain, Sec. 8, Tp. 23, R. 6, west of 5th M., seam 5 feet	F	2·74	18·62	75·52	3·12	....	....	....	*t*	B
Head waters of Mill and Pincher Creeks, Sec. 10, Tp. 5, R. 1, west of 5th M., seam 8 feet	....	1·99	20·88	61·87	15·26	....	....	....	*t*	B
Old Man River, north fork, 5 feet	S	1·75	16·85	61·54	19·86	....	1·530	11·32	*t*	B
" middle fork, 3 feet	S	3·27	26·41	50·50	19·82	....	1·432	11·13	*t*	B
" " 3 "	S	2·36	32·07	56·37	9·20	....	1·311	13·06	*t*	B
" south fork 9¾ "	F	1·93	23·23	57·50	17·34	....	....	....	*t*	B
Anthracite, Alberta Territory, H. W. McNeil & Co.—										
1st vein, raw	....	·10	13·09	78·94	7·87	....	....	....	....	F
" washed	....	·39	14·82	79·98	4·84	....	....	....	....	F
2nd vein, raw	....	·42	15·46	75·07	9·05	....	....	....	....	F
" washed	....	·40	6·02	89·40	4·18	....	....	....	....	F
3rd vein, raw	....	·08	15·12	76·67	8·13	....	....	....	....	F
" washed	....	·07	15·30	79·46	5·17	....	....	....	....	F

*† See page 57 s.

Coal.

Analyses.

ANALYSES OF CANADIAN COALS—*Continued.*

CROW'S NEST PASS, B.C.

Seam or Mine.	Fast or slow coking.	Moisture.	Vol. Matter.	Fixed Carbon.	Ash.	Sulphur.	Spec. Gravity.	Theor. Evap. Power.	*Analyst.	†Reference.
		p. c.	p. c.	p. c.	p. c.	p. c.				
Marten Creek—Peter seam, 14 ft.	S	1·79	25·45	69 14	3·62	·51	1·305	14·99	*t*	B
" Jubilee seam, 30 ft.	S	1·89	24·88	68·86	4·37	·48	1·309	14·64	*t*	B
" Four seams, 3, 4, 5 and 6 ft.	S	2·10	44·41	43·63	9·86	....	....	....	*t*	B
" Two-foot seam	F	2·12	26·92	43·48	27·48	....	....	....	*t*	B
" Middle seam, 2½ ft.	F	1·82	24·55	51·22	22·41	....	....	....	*t*	B
On Elk River, seam, 15 ft.	....	....	21·76	68·20	10·04	....	....	....	*t*	B

NANAIMO FIELD, B.C.

Seam or Mine.	Fast or slow coking.	Moisture.	Vol. Matter.	Fixed Carbon.	Ash.	Sulphur.	Spec. Gravity.	Theor. Evap. Power.	*Analyst.	†Reference.
Wellington Mines, Naniamo	....	2·75	30·95	59·72	6·58	....	....	....	*t*	B
Upper seam, Nanaimo	S	38·40		51·45	10·15	....	....	....	*t*	B
Newcastle Island, Nanaimo	S	1·57	30·95	58·03	8·63	0·82	....	....	*t*	B
" "	....	35·49		52·57	11·94	....	....	....	*t*	B

COAL.

Analyses.

COMOX FIELD, B.C.

Union Colliery	....	1·34	28·11	67·72	2·83	....	....	....	*t*	B
"	....	1·70	27·17	68·27	2·86	....	....	....	*t*	B
Baynes Sound Mine	....	1·18	34·13	48·51	16·18	....	....	....	*t*	B
Trent River	S	·97	25·09	66·42	5·95	1·57	....	....	*t*	B
Beaufort Mine, Comox	S	29·30		55·75	14·95	....	....	....	*t*	B

QUEEN CHARLOTTE ISLANDS, B.C.

Cowgitz (anthracite coal)	F	1·60	6·55	83·09	8·76	....	....	....	*t*	B
" Hooper Creek, Skidegate Channel	F	1·99	7·65	80·62	9·74	....	1·503	....	*t*	B
Camp Anthracite, Sec. 17, Tp. 5	F	1·52	8·69	80·07	9·72	....	....	....	*t*	B
" "	F	2·85	7·59	68·25	21·31	....	....	....	*t*	B
Camp Robertson, Sec. 20, Tp. 5, Graham Island, $6\frac{1}{2}$ miles west of Skidegate Inlet	F	·80	23·27	51·39	24·54	....	....	....	*t*	B
Camp Wilson, Sec. 36, Tp. 9	F	1·06	43·48	46·01	9·45	....	....	....	*t*	B
Yakoun River	S	2·65	30·59	61·33	5·43	....	....	....	*t*	B

*} †} See page 57 s

Copper.

COPPER.

Production.

The production of copper in the matte, etc., in Canada, in 1898, amounted to a total of 17,747,136 pounds, valued at $2,134.980 or 12·03 cents per pound, the average price for the year for fine copper in New York. This was an increase of 33 per cent in quantity and 42 per cent in value over the production of 1897 and nearly double the production of 1896.

Table 1.

Copper.

Annual Production.*

Calendar Year.	Lbs.	Increase or Decrease. Lbs.	Increase or Decrease. %	Value.	Increase or Decrease. $	Increase or Decrease. %	Average Price per Pound.
							Cts.
1886.......	3,505,000	....	....	$ 385,550	....	....	11.00
1887......	3,260,424	244,576	6·99	366,798	18,752	4·86	11.25
1888.	5,562,864	2,302,440	70.60	927,107	560,309	152·70	16.66
1889......	6,809,752	1,246,888	22·40	936,341	9,234	0·99	13.75
1890.......	6,013,671	796,081	11·69	947,153	10,812	1·15	15.75
1891.......	8,928,921	2,915,250	48·40	1,149,598	202,445	21·37	12.87
1892.. ..	7,087,275	1,841,646	20·62	818,580	331,018	28·79	11.55
1893......	8,109,856	1,022,381	14·40	871,809	53,229	6·50	10.75
1894..	7,708,789	401,067	4·94	736,960	134,849	15·46	9.56
1895.......	7,771,639	62,850	·81	836,228	99,268	13·47	10.76
1896... ..	9,393,012	1,621,373	20·86	1,021,960	185,732	22·21	10.88
1897.....	13,300,802	3,907,790	41.60	1,501,660	479,700	46·94	11.29
1898.......	17,747,136	1,501,660	33·43	2,134,980	633,320	42·17	12·03

* The production is altogether represented by the copper contained in ore, matte, &c., produced and shipped, valued at the average market price for the year for fine copper in New York.

Note.—In the above table increases are shown underlined, and decreases in the ordinary way.

The price of copper gradually increased during the year, the average price being in January about 11 cents, and in December, nearly 13 cents per pound. Copper.

Of the total production for the year 47 per cent came from Ontario, 41 per cent from British Columbia, and 12 per cent from Quebec. The production in Quebec was somewhat less in 1898 than in 1897 while in Ontario and British Columbia the increases were 50 per cent and 36 per cent respectively.

The exports of copper from Canada are given yearly in the Trade and Navigation Reports, and Table 2, following, has been compiled embodying the information for the calendar year for the past 14 years.

Although practically all the copper produced is exported either in the ore or in matte the figures of the table cannot be taken either in respect of quantity or value as indicative of the production of the country. It will be seen that they differ largely from the figures of Table 1.*

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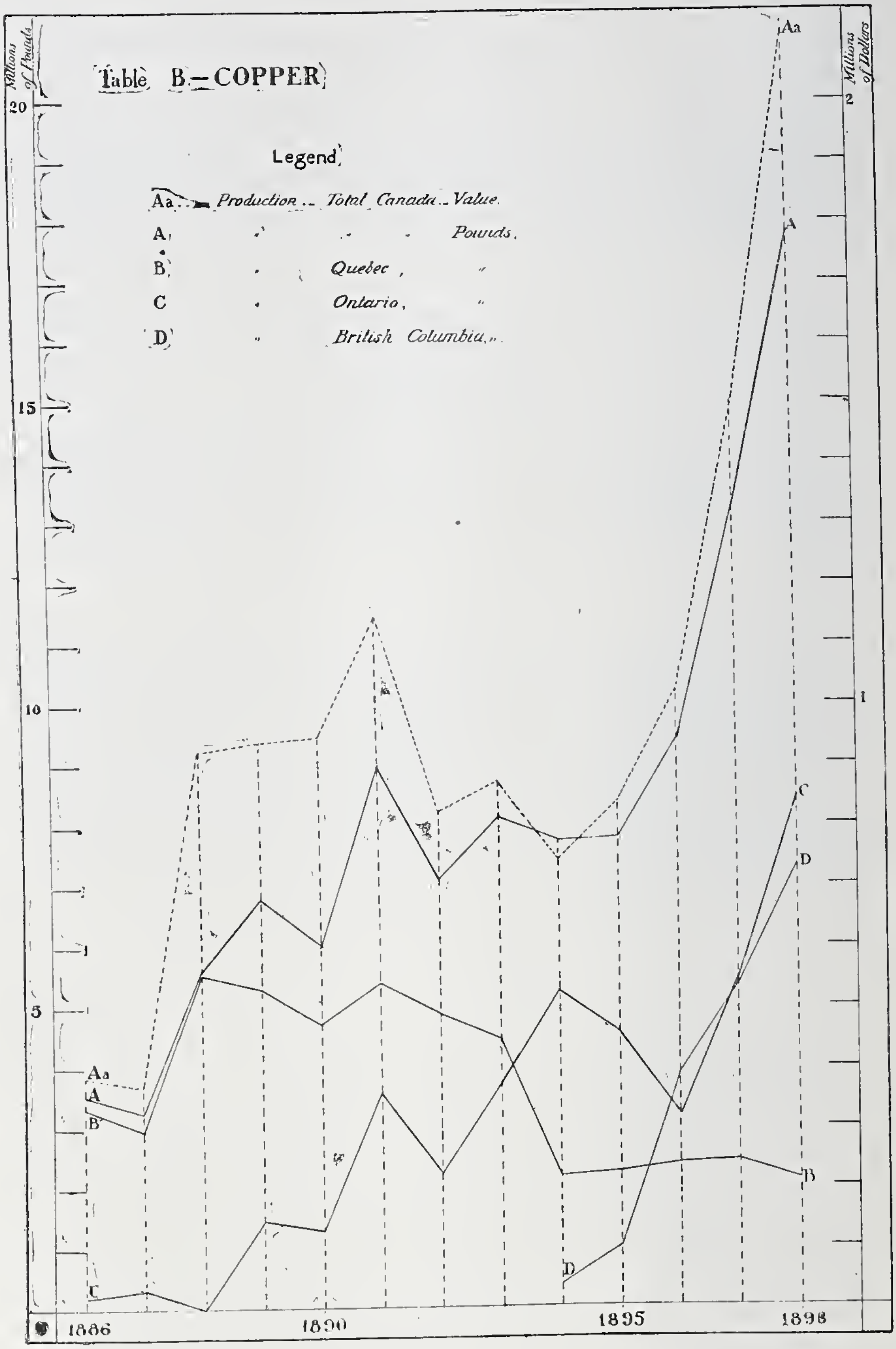
*The discrepancies between the two tables result from differences in both quantities and values. The values in Table 1 are similar to those adopted throughout the Report for metallic products, viz. : the final market value of the metal, while in the table of exports (Table 2) the values are apparently the spot values placed upon the metal at the point of shipment, although they will be seen to vary very considerably ; as for instance, in 1897, ranging from less than half a cent per pound in Ontario to nearly nine cents per pound in British Columbia. The figures of quantity, however, also show large discrepancies, and for this we can offer no explanation, except to make the suggestion that the returns to some of the customs officers are not as correct as they might be.

COPPER.

Production.



Copper. Exports.

TABLE 2.
COPPER.
EXPORTS OF COPPER IN ORE, MATTE, ETC.

Calendar Year.	Nova Scotia.		Ontario.		Quebec.		British Columbia.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
		$		$		$		$		$
1885						262,600				262,600
1886				16,404		232,855				249,259
1887				3,416		134,550				137,966
1888						257,260				257,260
1889						168,457				168,457
1890				2,219		396,278				398,497
1891				64,719		283,385				348,104
1892		100		79,141		198,391				277,632
1893			3,599,066	212,314	1,193,135	56,846			4,792,201	269,160
1894			242,804	25,029	285,909	12,005	1,097,576	54,883	1,625,389	91,917
1895			1,359,684	123,997	412,305	15,692	1,970,363	97,276	3,742,352	236,965
1896			49,000	1,100	290,845	12,368	5,122,207	267,602	5,462,052	281,070
1897			4,382,170	19,566	553,569	17,109	9,086,871	813,661	14,022,610	850,336
1898			3,800,000	6,071	340,389	34,054	7,431,992	800,118	11,572,381	840,243

Copper.

Imports.

The imports of copper into Canada are given in Tables 3 and 4. The total value of these imports in 1897 amounted to $270,036 while in 1898 it had advanced to $867,443 an increase of $597,407 or 221 per cent. The maximum importation in previous years was in 1891 when the value amounted to $573,974 but this has been exceeded in 1898 by over 50 per cent. The increase seems to have been fairly well distributed throughout the different forms or shapes into which the importation is subdivided although the increase of the importation of copper in pigs or ingots and copper in bolts, bars, rods, &c., are of sufficient importance to call for special mention. The classes of subdivision in 1898 are somewhat different from those used in 1897 owing to the changes in the tariff and therefore individual comparisons of special classes are more difficult to make.

Table 3.

Copper.

Imports of Pigs, Old, Scrap, etc.

Fiscal Year.	Lbs.	Value.
1880	31,900	$ 2,130
1881	9,800	1,157
1882	20,200	1,984
1883	124,500	20,273
1884	40,200	3,180
1885	28,600	2,016
1886	82,000	6,969
1887	40,100	2,507
1888	32,300	2,322
1889	32,300	3,288
1890	112,200	11,521
1891	107,800	10,452
1892	343,600	14,894
1893	168,300	16,331
1894	101,200	7,397
1895	72,062	6,770
1896	86,905	9,226
1897	49,000	5,449
1898 { Copper, old and scrap or in blocks ...... Duty free	13,100	1,069
1898 { Copper in pigs or ingots .... "	1,036,900	79,845
Total, 1898	1,050,000	$80,914

COPPER.

Imports.

TABLE 4.

COPPER.

IMPORTS OF MANUFACTURES.

Fiscal Year.				Value.
1880				$ 123,061
1881				159,163
1882				220,235
1883				247,141
1884				134,534
1885				181,469
1886				219,420
1887				325,365
1888				303,459
1889				402,216
1890				472,668
1891				563,522
1892				422,870
1893				458,715
1894				175,404
1895				251,615
1896				285,220
1897				264,587
		Duty.	Pounds.	
1898	Copper, in bolts, bars and rods, in coils, or otherwise in lengths not less than 6 feet, unmanufactured	Free.	3,808,900	$438,968
1898	Copper, in strips, sheets or plates, not planished or coated, &c	"	1,884,900	231,938
1898	Copper tubing in lengths not less than 6 feet, and not polished, bent or otherwise manufactured	"	127,546	23,270
1898	Copper rollers, for use in calico printing imported by calico printers for use in their own factories	"	....	3,063
1898	Copper and manufactures of :—			
1898	Nails, tacks, rivets and burrs or washers	30 p. c.	... .	3,131
1898	Wire, plain, tined or plated	15 "	354,015	49,399
1898	Wire cloth, &c	25 "	....	7,142
1898	All other manufactures of, N.O.P.	30 "	.. ..	29,618
	Total	....	....	786,529

QUEBEC.

The pyrites deposits in the township of Ascot, county of Sherbrooke, were worked to about the same extent as formerly and it is from these deposits that the copper production of Quebec is almost entirely obtained. The copper in the ore averaged for the year a little over 3 per cent; and the total obtained in 1898 was 2,100,235 pounds.

Besides the Eustis and Capelton properties, which are the chief producing mines of the district, some work was done at the Ascot mine on behalf of a Montreal syndicate. A small shipment was made which averaged 13 per cent. copper. The property has been leased to an

Copper.

American Company who are putting in a compressor and intend working the mine on a more extended scale.

Though not shipping any ore Dr. James Reed did some successful exploration work at the Harvey Hill mines in Leeds, Megantic county. A new vein of fine ore was found and he purposes sinking a shaft 300 feet.

Ontario.

Ontario.

In Ontario a property on lot 20 con. VI township of Barrie, Frontenac county, was being exploited and a small shipment yielded nearly 5 per cent copper.

The nickeliferous deposits of pyrrhotite at Sudbury, however, yielded practically all the copper product credited to this province. The operations in this district were considerably extended during the year and the output largely increased. The Canadian Copper Co., the chief producer has now five smelters in place of three, and is able to treat 600 tons of ore per day. Over 1,000 men are employed about the mines and works.

A more complete description of the work accomplished in this district will be found under the heading nickel.

The production of copper in Ontario as given by the Ontario Bureau of Mines is as follows in Table 5, with the exception of the final value which has been added to facilitate comparison with the other tables in this report.

Table 5.

Copper.

Ontario:—Production.

Calendar Year.	Pounds.	Spot Value.		Final Value.	
		Total.	Per lb.	Total.	Per lb.
		$	cts.	$	cts.
1892	3,872,000	232,135	6·00	447,216	11·55
1893	2,862,000	115,200	4·03	307,865	10·75
1894	5,496,000	195,750	3·56	525,418	9·56
1895	4,731,000	160,913	3·40	509,056	10·76
1896	3,736,000	130,660	3·50	406,477	10·88
1897	5,500,000	200,067	3·63	620,950	11·29
1898	8,373,560	268,080	3·20	1,007,339	12·03

COPPER.
British Columbia.

BRITISH COLUMBIA.

From a small beginning, in 1894, the production of copper in British Columbia has increased rapidly and in 1898 amounted to 7,271,678 lbs., and though not yet equalling the production of Ontario it nevertheless constitutes 41 per cent of the Dominion total. The increase over the previous year was 1,946,498 lbs. or 36 per cent.

The details of production for the past five years are given below in Table 6, the figures of production and spot values being taken from the Report of the Minister of Mines and the final values given in the last column calculated at the same rate per lb. as the value in Table 1.

TABLE 6.

COPPER.

BRITISH COLUMBIA :—PRODUCTION.

Calendar Year.	Copper contained in ores, matte, &c.	Increase.		Spot Value.	Final Value.
	Lbs.	Lbs.	%		
1894	324,680	....	.....	$ 16,234	$ 31,039
1895	952,840	628,160	193	47,642	102,526
1896	3,818,556	2,865,716	301	190,926	415,459
1897	5,325,180	1,506,624	39	266,258	601,213
1898	7,271,678	1,946,498	36	*	874,783

*The value adopted in the Report of the Minister of Mines for 1898 is practically the final value given above.

The copper is derived almost entirely from the so-called gold ores of Rossland and the silver-copper ores of Nelson in West Kootenay. These divisions contributed respectively in 1898, Trail Creek 72 per cent and Nelson about 29 per cent to the total provincial copper production, while in 1897 the respective proportions contributed were Trail Creek 34 per cent and Nelson about 65 per cent indicating a reversal of the relative importance of these two divisions as regards copper production. Not only was the quantity of ore from Trail Creek treated in 1898 much greater than that treated in 1897, the increase being 76 per cent., but the percentage of copper in these Rossland ores averaged in 1898 2·35 per cent as compared with 1·32 per cent in 1897. In the division of Nelson about the same quantity of ore was treated as during the previous year, but the copper contents in 1898

Copper. British Columbia.

averaged only 1·85 per cent while in 1897 they were 3·45 per cent. Thus it will be seen (see also Precious Metals) that while in the Nelson division both the silver and copper contents of the ore per ton were less in 1898 than in 1897, in the Trail Creek division the average contents of the precious metals was less and of copper greater.

"A few hundred tons of fair copper ore have been shipped from Van Anda, on Texada Island, and a smaller quantity from mines of Vancouver Island, but more as trial than regular shipments.

"There are, however, a large number of promising copper prospects in the Fort Steele, and also in the Windermere and Donald divisions of East Kootenay, * * * Vancouver Island has also shown up a few prospects which may soon become producers, notably the 'Lenora' on Mount Sicker, and certain properties on the west Coast." (Report of the Minister of Mines for B.C., 1898, p. 971.)

Graphite.

GRAPHITE.

The total value of the graphite production in Canada in 1898 was $13,698 a decrease of $2,542 from the value of the production in 1897. Complete returns of the quantities produced were not received, consequently the number of tons cannot be given. There were, however, over 550 tons of the cruder material shipped besides smaller quantities of more highly finished product, the different grades produced, ranging all the way from the crudest and cheapest material used in paint making to the highest grades of finished graphite. This variableness of product has been a feature of the graphite industry as will be seen by a reference to Table 1, the value per ton ranging from $6 to $77. This somewhat unsatisfactory method of grouping the whole production might be avoided by giving a more detailed statement of the various grades produced, but owing to the small number of operators and the confidential nature of the returns sent to the Department this cannot very well be done and hence only the totals are given.

TABLE 1.

GRAPHITE.

ANNUAL PRODUCTION.

GRAPHITE. Production.

Calendar Year.	Tons.	Value.
1886	500	$4,000
1887	300	2,400
1888	150	1,200
1889	242	3,160
1890	175	5,200
1891	260	1,560
1892	167	3,763
1893	nil.	nil.
1894*	3	223
1895	220	6,150
1896	139	9,455
1897	436	16,240
1898	....	13,698

* Exports.

Tables 2 and 3 give the exports and imports of graphite, the total value of the exports of crude and manufactured graphite being in 1898 $13,098 and the imports $54,198.

TABLE 2.

GRAPHITE.

EXPORTS.

Exports.

Calendar Year.	New Brunswick.		Ontario.		Quebec.		Nova Scotia.	
	Cwt.	Value.	Cwt.	Value.	Cwt.	Value.	Cwt.	Value.
		$		$		$		$
1886	8,142	3,586	....	....	....	....	....	....
1887	6,294	3,017	....	....	....	....	....	....
1888	2,700	1,080	....	....	....	....	....	....
1889	660	422	22	116	....	....	....	
1890	400	160	329	1,369	....	....	....	....
1891	464	72	....	....	....	....	....	....
1892	1,224	449	15	60	4,590	3,443	....	....
1893	....	....	12	38	....	....	....	....
1894	....	....	69	223	....	....	....	....
1895	1	8	1,087	4,825	....	....	....	....
1896	270	106	2,285	7,418	....	351	160	1,605
1897	....	....	850	1,286	....	1,332	3,240	1,707
1898 { Crude	1,356	638	10,445	10,878	3	4	9	10
1898 { Manufact'd.	....	....	....	....	....	1,571	....	....
	1,356	635	10,445	10,878	3	1,575	9	10

Graphite.
Imports.

TABLE 3.

GRAPHITE.

IMPORTS OF RAW AND MANUFACTURED PLUMBAGO.

Fiscal Year.		Plumbago.	Manufactures of plumbago. Black-lead.	Other Manufactures.
1880		$1,677	$18,055	$2,738
1881		2,479	26,544	1,202
1882		1,028	25,132	2,181
1883		3,147	21,151	2,141
1884		2,891	24,002	2,152
1885		3,729	24,487	2,805
1886		5,522	23,211	1,408
1887		4,020	25,766	2,830
1888		3,802	7,824	22,604
1889		3,546	11,852	21,789
1890		3,441	10,276	26,605
1891		7,217	8,292	26,201
1892		2,988	13,560	23,085
1893		3,293	16,595	23,051
1894		2,177	17,614	16,686
1895		2,586	13,922	21,988
1896		2,865	18,434	19,497
1897		1,406	17,863	20,674
	Duty.			
1898 Plumbago, not ground, &c.	10 p.c.	$1,862		
1898 Black-lead	25 "		$ 19,683	
1898 Plumbago, ground and manufactures of, N.E.S.	25 "			$20,120
1898 Crucibles, clay or plumbago				12,533
Total, 1898		$1,862	$19,638	$32,653

In New Brunswick low grade graphite was mined at Carleton near St. John and shipped to Montreal to be manufactured into paint, etc.

Two mines in Quebec in the Buckingham district, Labelle county, were operated to a small extent. The North American Graphite Co. mined for development and experimental purposes and the Buckingham Company shipped a quantity of finished product. Both properties have mills for extracting the graphite, besides the necessary buildings such as store houses, repair shops, boarding houses, etc. The mines and works of the Walker Mining Co. in the same district were not operated during the year.

The Black Donald Mine, Renfrew county, Ontario, was worked by the Ontario Graphite Co. and the crude graphite shipped to the United States.

GYPSUM.

GYPSUM.

Production.

Gypsum mining during 1898 was practically confined to the same localities worked during the previous year in the provinces of Nova Scotia, New Brunswick and Ontario. The production shows but slight variation from the figures of 1897, the total output of crude gypsum and the various manufactured products being 219,256 tons valued at $232,515, or an average value per ton of $1.06. Compared with 1897 this is a decrease of 20,435 tons, or 8·52 per cent in quantity, and $12, 016 or 4·91 per cent in value.

The production in Nova Scotia was somewhat less than for the previous year and in New Brunswick slightly greater. In the former province the output is almost entirely crude gypsum, while in New Brunswick over one-third the value is in the product, plaster of Paris.

TABLE 1.

GYPSUM.

ANNUAL PRODUCTION.

Calendar Year.	Tons.	Value.	Average price per ton.
1886	162,000	$178,742	$ 1.10
1887	154,008	157,277	1.02
1888	175,887	179,393	1.01
1889	213,273	205,108	0.96
1890	226,509	194,033	0.86
1891	203,605	206,251	1.01
1892	241,048	241,127	1.00
1893	192,568	196,150	1.02
1894	223,631	202,031	0.90
1895	226,178	202,608	0.89
1896	207,032	178,061	0.86
1897	239,691	244,531	1.02
1898 Nova Scotia	132,086	106,610	.81
1898 New Brunswick	86,083	121,704	1.41
1898 Ontario	1,087	4,201	3.86
Total, 1898	219,256	$232,515	$1.06

Gypsum. Production.

The production for 1897 arranged according to class of product was given in the Report for that year as :

—	Tons.	Value.	Value per Ton.
		$	$ cts.
Crude gypsum	228,416	187,918	0 82
Calcined and land plaster	1,956	4,753	2 43
Plaster of Paris and terra alba	9,319	51,860	5 62
Total	239,691	244,531	1 02

The production in 1898 similarly classified was :

—	Tons.	Value.	Value per Ton.
		$	$ cts.
Crude gypsum	208,061	174,445	0 84
Calcined and land plaster	1,583	4,574	2 89
Plaster of Paris and terra alba	9,612	53,496	5 57
Total	219,256	232,515	1 06

These figures show decreases in the cruder products and a slight increase in the plaster of Paris product.

TABLE 2.
GYPSUM.
ANNUAL PRODUCTION BY PROVINCES.

GYPSUM.
Production.

Calendar Year.	Nova Scotia.		New Brunswick.		Ontario.		Total.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
		$		$		$		$
1886......	....	....	....	....	.....	....	162,000	178,742
1887.. ...	116,346	116,346	29,102	29,216	8,560	11,715	154,008	157,277
1888 .. .	124,818	120,429	44,369	48,764	6,700	10,200	175,887	179,393
1889.....	165,025	142,850	40,866	49,130	7,382	13,128	213,273	205,108
1890......	181.285	154.972	39,024	30,986	6,200	8,075	226.509	194,033
1891......	161,934	153,955	36,011	33,996	5,660	18,300	203,605	206,251
1892	197,019	170,021	39,709	65,707	4,320	5,399	241,048	241,127
1893	152,754	144,111	36,916	41,846	2,898	10,193	192,568	196,150
1894......	168,300	147,644	52,962	48,200	2,369	6,187	223,631	202,031
1895 ..	156,809	133,929	66,949	63,839	2,420	4,840	226,178	202,608
1896	136,590	111,251	67,137	59,024	3,305	7,786	207,032	178,061
1897......	155,572	121,754	82,658	118,116	1,461	4,661	239,691	244,531
1898......	132,086	106,610	86,083	121.704	1,087	4,201	219,256	232,515

As will be seen from Tables 3 and 4, the greater part of the production is exported. The imports of gypsum, etc., are shown in Table 5.

TABLE 3.
GYPSUM.
EXPORTS OF CRUDE GYPSUM.

Exports.

Calendar Year.	Nova Scotia.		New Brunswick.		Ontario.		Total.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
1874	67,830	$ 68,164	....	....	......	....	67,830	$ 68,164
1875	86,065	86,193	5,420	$ 5,420	......	....	91,485	91,613
1876	87,720	87,590	4,925	6,616	120	$ 180	92,765	94,386
1877	106,950	93,867	5,030	5,030	......	....	111,980	98,897
1878	88,631	76,695	16,335	16,435	489	675	105,455	93,805
1879	95,623	71,353	8,791	8,791	579	720	104,993	80,864
1880	125,685	111,833	10,375	10,987	875	1,240	136,935	124,060
1881	110,303	100,284	10,310	15,025	657	1,040	121,270	116,349
1882	133,426	121,070	15,597	24,581	1,249	1,946	150,272	147,597
1883	145,448	132,834	20,242	35,557	462	837	166,152	169,228
1884	107,653	100,446	21,800	32,751	688	1,254	130,141	134,451
1885	81,887	77,898	15,140	27,730	525	787	97,552	106,415
1886	118,985	114,116	23,498	40,559	350	538	142,833	155,213
1887	112,557	106,910	19,942	39,295	225	337	132,724	146,542
1888	124,818	120,429	20	50	670	910	125,508	121,389
1889	146,204	142,850	31,495	50,862	483	692	178,182	194,404
1890	145,452	139,707	30,034	52,291	205	256	175,691	192,254
1891	143,770	140,438	27,536	41,350	5	7	171,311	181,795
1892	162,372	157,463	27,488	43,623	......	....	189,860	201,086
1893	132,131	122,556	30,061	36,706	......	....	162,192	159,262
1894	119,569	111,586	40,843	46,538	......	....	160,412	158,124
1895	133,369	125,651	56,117	67,593	......	....	189,486	193,244
1896	116,331	109,054	64,946	77,535	......	....	181,277	186,589
1897	122,984	116,665	66,222	80,485	......	....	189,206	197,150
1898	99,215	93,474	70,399	81,433	......	....	169,614	174,907

Gypsum.

Exports.

TABLE 4.

GYPSUM.

EXPORTS OF GROUND GYPSUM.

Calendar Year.	Nova Scotia.	New Brunswick.	Ontario.	Total.
	$	$	$	$
1890	....	....	....	105
1891	....	....	....	588
1892	....	....	....	20,255
1893	....	....	....	22,132
1894	2,124	17,930	....	20,054
1895	3,364	18,827	42	22,233
1896	1,270	19,246	751	21,267
1897	1,655	5,024	84	6,763
1898	1,548	4,900	....	6,448

Imports

TABLE 5.

GYPSUM.

IMPORTS OF GYPSUM, ETC.

Fiscal Year.	Crude Gypsum.		Ground Gypsum.		Plaster of Paris.	
	Tons.	Value.	Pounds.	Value.	Pounds.	Value.
1880	1,854	$3,203	1,606,578	$ 5,948	667,676	$ 2,376
1881	1,731	3,442	1,544,714	4,676	574,006	2,864
1882	2,132	3,761	759,460	2,576	751,147	4,184
1883	1,384	3,001	1,017,905	2,579	1,448,650	7,867
1884	....	3,416	687,432	1,936	782,920	5,226
1885	1,353	2,354	461,400	1,177	689,521	4,809
1886	1,870	2,429	224,119	675	820,273	5,463
1887	1,557	2,492	13,266	73	594,146	4,342
1888	1,236	2,193	106,068	558	942,338	6,662
1889	1,360	2,472	74,390	372	1,173,996	8,513
1890	1,050	1,928	434,400	2,136	693,435	6,004
1891	376	640	36,500	215	1,035,605	8,412
1892	626	1,182	310,250	2,149	1,166,200	5,595
1893	496	1,014	140,830	442	552,130	3,143
1894	....	1,660	23,270	198	422,700	2,386
1895	603	960	20,700	88	259,200	1,619
1896	1,045	848	64,500	198	297,000	2,000
1897	....	772	45,000	123	969,900	4,489
1898	1,147	1,742	*35,700	293	329,600	2,025

* 119 barrels.

Crude gypsum, duty free. Ground gypsum, duty 15 p. c. Plaster of Paris, duty 12½c. per 100 lbs.

The chief points of activity in gypsum mining in 1898 in Nova Scotia were the quarries near Windsor and Cheverie, Hants county. Several thousand tons were shipped from the quarries near Baddeck, C.B., and a small quantity from the Lennox Ferry deposit in Richmond county, C.B. The Victoria Gypsum Mining Co., which was operating at Baddeck, did considerable work in opening up a new deposit at St. Ann's Harbour, C.B. Gypsum.

In New Brunswick the Hillsborough quarries, Albert county, were operated more extensively, and the output increased. With the exception of a small production near Andover, Victoria county, these were the only quarries worked in this province during the year.

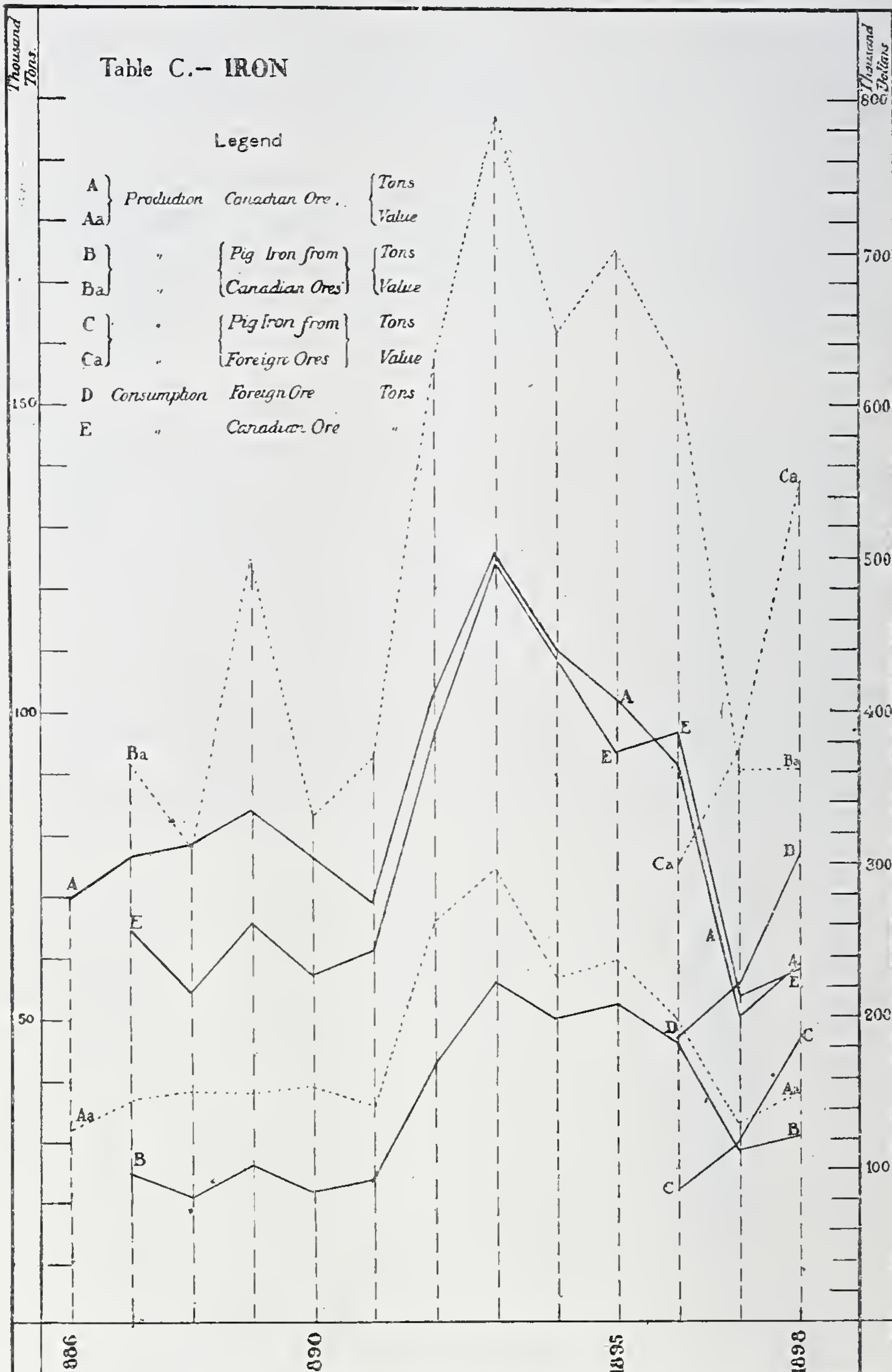
IRON.

Iron.

The production of iron ore in Canada in 1898, which is represented almost entirely by the ore used during the year in the blast furnaces in the manufacture of pig iron, amounted to 58,343 tons, valued at $152,788, or $2.62 per ton, which though an increase of 7,638 tons or 15 per cent in quantity and $22,498 or 17 per cent in value over the production of the previous year, is nevertheless with the exception of 1897 the least production recorded in 12 years. These figures, of course, do not represent the total value of the iron industry of the country on the same basis on which the other metallic minerals are valued throughout the report. This value will, perhaps, be better indicated by the production of pig-iron, which is taken up further on.

IRON.
Production.

The annual production of ore, pig iron, etc., since 1886 is shown graphically in Table C below :—



The production of ore by provinces in 1898 was as follows :—

IRON.

Production of ore.

Province.	Tons.	Value.
		$
Nova Scotia	19,079	42,928
Quebec	17,873	46,033
Ontario	21,111	63,077
British Columbia	280	750
Total	58,343	152,788

The production of ore by provinces from 1886 to 1897 is given in Table 1, while in Table 2, the production in Nova Scotia since 1876 is shown.

TABLE 1.

IRON.

PRODUCTION OF ORE BY PROVINCES.

Province.	1886.	1887.	1888.	1889.	1890.	1891.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Nova Scotia	44,388	43,532	42,611	54,161	49,206	53,649
Quebec	....	13,404	10,710	14,533	22,305	14,380
Ontario	16,032	16,598	16,894	....	5,000	....
British Columbia	3,941	2,796	8,372	15,487	....	950
Total	64,361	76,330	78,587	84,181	76,511	68,979

Province.	1892.	1893.	1894.	1895.	1896.	1897.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Nova Scotia	78,258	102,201	89,379	83,792	58,810	23,400
Quebec	22,690	22,076	19,492	17,783	17,630	22,436
Ontario	....	....	....	....	15,270	2,770
British Columbia	2,300	1,325	1,120	1,222	196	2,099
Total	103,248	125,602	109,991	102,797	91,906	50,705

IRON.

The relative proportion of the output of ore by the different provinces in each of the last five years is shown in the following table :—

Production of ore.

Province.	1894.	1895.	1896.	1897.	1898.
	%	%	%	%	%
Nova Scotia	81·26	81·51	63·99	46·15	32·70
Quebec	17·72	17·30	19·18	44·25	30·63
Ontario	....	....	16·62	5·46	36·19
British Columbia	1·02	1·19	0·21	4·14	·48
	100·00	100·00	100·00	100·00	100·00

TABLE 2.

IRON.

NOVA SCOTIA :—ANNUAL PRODUCTION OF ORE.

Calendar Year.	Tons.
1876	15,274
1877	16,879
1878	36,600
1879	29,889
1880	51,193
1881	39,843
1882	42,135
1883	52,410
1884	54,885
1885	48,129
1886	44,388
1887	43,532
1888	42,611
1889	54,161
1890	49,206
1891	53,649
1892	78,258
1893	102,201
1894	89,379
1895	83,792
1896	58,810
1897	23,400
1898	19,079

The production in Nova Scotia will be seen to have diminished steadily since 1893, while the figures for Ontario show a considerable increase in 1898, due to the reopening of the mines in the eastern part of the province the ore from which was used in the furnace in Hamilton. In 1896 and previous years, Nova Scotia produced more iron ore than all the other provinces combined, but in 1897, the percentage supplied by this province fell to 46·15, and in 1898 Ontario was the largest producer with 36·19 per cent of the total production.

The exports of iron ore, which are of small amount in recent years are given in Table 3. IRON.

TABLE 3.

IRON.

EXPORTS OF ORE.

Exports of ore

Province.	1895. Tons.	1895. Value.	1896. Tons.	1896. Value.	1897. Tons.	1897. Value.	1898. Tons.	1898. Value.
	Calendar Years.							
Ontario..........	....	....	*1,033	$ 1,911	.. ..	......	143	$ 172
Quebec..........	....	....	.....	.....	151	$ 286	39	106
Nova Scotia.....	....	....	.....	.....	....	.....	....	....
British Columbia.	1,571	$ 3,909	......	......	252	525	....	....
Total........	1,571	$ 3,909	1,033	$1,911	403	$ 811	182	$ 278

There were four furnaces in blast during the year for longer or shorter periods, one in Nova Scotia, two in Quebec and one in Ontario. The Nova Scotia Steel Co. produced about the same quantity of pig-iron as during the previous year. Besides the local ores used considerable quantities were imported from Newfoundland and some from Cuba. Of the total ore charged 47·5 per cent was mined in Canada and 52·5 per cent imported. The furnace of the Pictou Charcoal Iron Co., which had been leased to the Mineral Products Co. of New York, was undergoing alterations and the manufacture of ferro-manganese had not yet been commenced. The furnace of the Londonderry Iron Co. was still idle, though several thousand tons of castings were turned out from their foundry. In Quebec the furnaces at Radnor and Drummondville Forges, owned resepctively by the Canada Iron Furnace Co. and John McDougall & Co. of Montreal, were operated as usual, utilizing the bog iron ores of the surrounding districts. These iron ores are taken out chiefly by farmers working during slack months. The new furnace at Deseronto, in Ontario, built by the Deseronto Iron Co. for the manufacture of charcoal iron, was practically completed, but not in time to begin operations in 1898. The Hamilton Blast Furnace Co. was therefore the only company making pig-iron in Ontario. The output for 1898 was about double that in 1897. The ore used came mainly from the Lake Superior iron mines, though in 1898 the mines of eastern Ontario were again opened up. The proportions of Canadian and foreign ore used in 1898 in this furnace were 27·2 per cent and 72·8 per cent respectively. In 1897, the percentages were respectively 18·95 and 81·05. Blast furnace

The total production of pig iron in Canada during the year from Canadian and foreign ores was 77,015 tons, valued at $912,395, an

Iron.

average value per ton of $11.85, which, when compared with the previous year, shows an increase of 19,008 tons, or 32·73 per cent and $173,694 or 23·51 per cent in value. The total quantity of ore used in this production was 134,988 tons, of which 57,881 tons or 43 per cent was mined in Canada, and the balance, 77,107 tons or 57 per cent imported.

Production Pig Iron.

To estimate the approximate amount of pig-iron which should be credited to Canadian ore the output of each furnace has been divided in the proportion of the Canadian and foreign ores entering into its composition. On this basis the production of pig-iron in the past three years has been as follows:—

Year.	From Canadian Ore.	From Foreign Ore.
	Tons.	Tons.
1896	40,720	26,546
1897	26,200	31,807
1898	30,553	46,462

Lacking the necessary data as to the average iron contents of the two classes of ore used, the above figures are of course based on the assumption that the two were equal in this respect. This surmise is probably nearly correct, but the figures given are necessarily only approximate.

The books of the Customs Department show that bounties were paid during the calendar year on pig-iron produced in Canada, representing $27,356\frac{1341}{2000}$ tons of home ore, $47,423\frac{1387}{2000}$ of foreign. The discrepancy between these figures and those given above is probably due to the fact that the payment of the bounties is not altogether made in the same year as that in which the pig was produced.

The annual production of pig iron is given in Table 4.

IRON.

Production of Pig Iron.

TABLE 4.
IRON.
PIG IRON PRODUCTION: CONSUMPTION OF ORE, FUEL, ETC.

Calendar Year.	Iron Ore Consumed.		Fuel Consumed.						Flux Consumed.		Pig Iron Made.		
			Charcoal.		Coke.		Coal.						
	Tons.	Value.	Bushel.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Value per ton.
		$		$		$		$		$		$	$
1887	60,434	130,808	940,400	48,593	30,248	89,123	3,333	5,877	17,171	17,500	24,827	366,192	14.75
1888	54,956	102,343	804,286	41,800	28,031	82,986	2,197	4,709	16,857	16,533	21,799	313,235	14.37
1889	65,670	126,064	755,800	41,568	33,289	94,791	3,044	6,525	22,122	21,909	25,921	499,872	19.28
1890	57,304	117,880	589,860	29,493	32,832	97,659	1,241	2,638	18,478	18,361	21,772	331,688	15.23
1891	60,933	130,955	441,812	22,091	30,626	98,402	2,170	2,868	11,377	11,546	23,891	368,901	15.44
1892	96,948	250,966	1,121,365	78,291	50,882	152,311	1,740	1,797	22,967	21,687	42,443	637,421	15.02
1893	124,053	296,979	1,302,720	90,976	58,711	163,849	6,621	13,539	27,797	27,519	55,947	790,283	14.13
1894	108,871	223,861	1,173,970	53,958	52,373	142,303	7,653	14,571	35,101	34,347	49,967	646,447	12.94
1895	93,208	218,336	789,561	31,582	48,540	139,475	3,089	5,396	31,585	29,922	52,454	696,440	13.28
1896	(a) 96,560	200,887	756,600	32,256	(a) 48,660	106,939	1,407	2,288	37,462	36,140	67,268	924,129	13.74
	(b) 46,300	100,205			(b) 33,990	109,253							
1897	(a) 53,658	131,705	1,031,800	43,230	(a) 35,800	71,600	......	....	31,273	30,258	58,007	738,701	12.73
	(b) 55,722	138,504			(b) 27,810	94,553							
1898	(a) 57,881	151,760	836,400	41,820	(a) 31,952	63,904	......	....	33,913	31,153	77,015	912,395	11·85
	(b) 77,107	213,165			(b) 50,407	158,783							

(a) Canadian. (b) Foreign.

IRON.

Table 5 shows the exports of iron and steel goods, the total of which varies but little from that of the previous year.

Exports.

TABLE 5.

IRON.

EXPORTS OF IRON AND STEEL GOODS, THE PRODUCT OF CANADA.

CALENDAR YEAR 1898.

Province.	Scrap Iron.	Iron Stoves.	Iron Castings.	Pig Iron.	*Iron, all other, and Hardware.	Steel and manufactures of.	Totals.
	$	$	$	$	$	$	$
Ontario	2,006	541	81,290	1,510	133,795	31,586	250,728
Quebec	4,315	610	22,287	30,855	179,405	4,867	242,339
Nova Scotia	....	2,768	4,331	280	50,441	15,429	73,249
New Brunswick	137	96	....	.....	4,251	120	4,604
Prince Edward Island	....	.....	8	......	271	.....	279
Manitoba	.....	.. ..	....	......	5,924	946	6,870
North-West Territories	356	. ....	....	.....	394	29	779
British Columbia	275	......	134	......	12,623	1,180	14,212
Total	7,089	4,015	108,050	32,645	387,104	54,157	593,060

*Machinery, N.E.S. ; sewing machines and hardware, N.E.S.

The imports of iron in its cruder forms are shown in Tables 6, 7 and 8. These tables, as well as 9a and 9b following are made up from the Trade and Navigation Reports and are for the fiscal year.

IRON.

Imports.

TABLE 6.

IRON.

IMPORTS OF IRON, PIG, SCRAP, ETC.

Fiscal Year.	Pig Iron.		Charcoal Pig Iron.		Old and Scrap Iron.		Wrought Scrap and Scrap Steel.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
		$		$		$		$
1880	23,159	(a) 371,956	....	....	928	14,042	....	....
1881	43,630	(a) 715,997	....	.. ....	584	8,807	....	. ...
1882	56,594	811,221	6,837	211,791	1,327	20,406	....	....
1883	75,295	1,085,755	2,198	58,994	709	7,776	....	....
1884	49,291	653,708	2,893	66,602	3,136	44,223	....	....
1885	42,279	545,426	1,119	27,333	3,552	46,275	....	....
1886	42,463	528,483	3,185	60,086	10,151	158,100	... .	.. . . ..
1887	46,295	554,388	3,919	77,420	17,612	220,167	(b) 79	1,086
	Pig Iron, etc. (c)							
	Tons.	Value.						
		$						
1888	48,973	648,012	....	....	....	....	23,293	297,496
1889	72,115	864,752	....	....	....	....	26,794	335,090
1890	87,613	1,148,078	....	....	....	....	47,846	678,574
1891	81,317	1,085,929	....	....	....	....	43,967	652,842
1892	68,918	886,485	....	....	....	....	32,627	433,695
	Pig Iron.		Charcoal Pig Iron.		Cast Scrap Iron.			
	Tons.	Value.	Tons.	Value.	Tons.	Value.		
		$		$		$		
1893	56,849	682,209	5,944	84,358	729	9,317	45,459	574,809
1894	42,376	483,787	2,906	34,968	78	771	30,850	369,682
1895	(d) 31,637	341,259	2,780	31,171	643	4,347	23,390	244,388
1896	(d) 36,131	394,591	917	11,726	93	741	(e)13,607	157,996
1897	(d) 25,766	291,788	2,936	35,373	238	1,362	7,903	93,541
1898	(d) 37,186	382,103	(f) 2,250	23,533	(f) 1,559	13,251	(e)48,903	534,577

(a) Comprises pig-iron of all kinds.

(b) From May 13 only.

(c) These figures appear in Customs reports under heading 'Iron in pigs, iron kentledge and cast scrap-iron.'

(d) Includes iron kentledge. Duty $2.50 per ton.

(e) Scrap iron and scrap steel, old, and fit only to be remanufactured, being part of, or recovered from, any vessel wrecked in waters subject to the jurisdiction of Canada. Duty free.

Iron or steel scrap, wrought, being waste or refuse, including punchings, cuttings and clippings of iron or steel plates or sheets, having been in actual use, crop ends of tin plate bars, blooms and rails, the same not having been in actual use. Duty $1 per ton.

(f) Duty $2.50 per ton.

Iron.

Imports.

Table 7.

Iron.

Imports of Ferro-manganese, etc.

Fiscal Year.	Tons.	Value.
*1887	123	$ 1,435
*1888	1,883	29,812
*1889	5,868	72,108
*1890	696	18,895
*1891	2,707	40,711
*1892	1,311	23,930
*1893	529	15,858
*1894	284	9,885
†1895	164	5,408
†1896	652	12,811
†1897	426	9,233
†1898 (Duty 5 p.c.)	1,418	22,516

* These amounts include:—ferro-manganese, ferro-silicon, spiegel, steel bloom ends, and crop ends of steel rails, for the manufacture of iron or steel.

† Ferro-silicon, spiegeleisen and ferro-manganese.

Table 8.

Iron.

Imports : Iron in Slabs, Blooms, Loops and Puddle Bars, etc.

Fiscal Year.	Cwt.	Value.
1880	195,572	$244,601
1881	111,666	111,374
1882	203,888	222,056
1883	258,639	269,818
1884	252,310	264,045
1885	312,329	287,734
1886	273,316	248,461
1887	522,853	421,598
1888	110,279	93,377
1889	80,383	67,181
1890	15,041	45,923
1891	41,567	38,931
1892	64,397	56,186
1893	65,269	58,533
1894	50,891	45,018
1895	78,639	67,321
1896	128,535	110,757
1897	56,560	48,954
1898*	162,891	122,426

*Iron or steel ingots, cogged ingots, blooms, slabs, billets, puddled bars, and loops or other forms, N.O.P., less finished than iron or steel bars, but more advanced than pig-iron, except castings. Duty $2 per ton.

TABLE 9a.

IRON.

IMPORTS OF IRON AND STEEL GOODS.

IRON.

Imports.

Fiscal Year 1898.		Duty.	Quantity.	Value.
				$
Bar iron or steel, rolled, whether in coils, bundles, rods or bars, comprising rounds, ovals, squares and flats, and rolled shapes, N.O.P.	Cwt.	$7 per ton.	269,945	372,297
Castings, iron or steel, in the rough, N.E.S.	$	25 p. c.	....	79,717
Canada plates, Russia iron, flat galvanized iron or steel sheets, terne plate, and rolled sheets of iron or steel coated with zinc, spelter or other metal, of all widths or thicknesses, N.O.P.	Cwt.	5 "	378,641	704,290
Iron or steel bridges or parts thereof, iron or steel structural work, columns, shapes or sections, drilled, punched, or in any further stage of manufacture than as rolled or cast, N.E.S.	"	35 "	261,721	438,634
Malleable iron castings, and iron or steel castings, N.E.S.	"	25 "	21,363	32,214
Mould boards, or shares or plough plates, land sides and other plates for agricultural implements, cut to shape from rolled plates of steel, but not moulded, punched, polished, or otherwise manufactured	"	5 "	29,680	96,722
Iron or steel railway bars or rails of any form, punched or not punched, N.E.S., for railways, which term for the purposes of this item shall include all kinds of railways, street railways and tramways, even although the same are used for private purposes only, and even although they are not used or intended to be used in connection with the business of common carrying of goods or passengers	Tons.	30 "	7,290	89,912
Railway fish-plates and tie-plates	"	$8 per ton.	7,828	171,605
Rolled iron or steel angles, tees, beams, channels, joists, girders, zees, stars or rolled shapes, or trough, bridge, building or structural or rolled sections or shapes, not punched, drilled or further manufactured than rolled, N.E.S.; and flat eye bar blanks not punched or drilled	Cwt.	10 p. c.	227,441	248,621
Rolled iron or steel hoop, band, scroll or strip, 8 inches or less in width, No. 18 gauge and thicker, N.E.S.	"	$7 per ton.	23,405	32,571
Rolled iron or steel hoop, band, scroll or strip, thinner than No. 18 gauge, N.E.S.	"	5 p. c.	30,121	55,379
Rolled iron or steel angles, tees, beams, channels, girders and other rolled shapes, or sections, weighing less than 35 lbs. per lineal yard, not punched, drilled or further manufactured than rolled, N.O.P.	"	$7 per ton.	80,826	83,920
Rolled iron or steel plates or sheets, sheared or unsheared, and shelf iron or steel, sheared or rolled in grooves, N.E.S.	"	$7 "	64,918	83,299
Carried forward		....	....	2,489,181

Iron.

Imports.

TABLE 9a—*Continued.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year 1898.	Duty.	Quantity.	Value.
			$
Brought forward			2,489,181
Rolled iron or steel plates, not less than 30 inches in width, and not less than ¼ inch in thickness, N.O.P. Cwt.	10 p. c.	166,854	185,166
Rolled iron or steel sheets, No. 17 gauge and thinner, N.O.P. "	5 "	176,531	279,422
Rolls of chilled iron or steel "	30 "	1,377	4,743
Skelp iron or steel, sheared or rolled in grooves, imported by manufacturers of wrought iron or steel pipe for use only in the manufacture of wrought iron or steel pipe in their own factories "	5 "	148,954	138,052
Swedish rolled iron and Swedish rolled steel nail rods under half an inch in diameter, for the manufacture of horse-shoe nails "	15 "	24,549	44,766
Switches, frogs, crossings and intersections for railways "	30 "	7,168	3,303
Steel—Chrome steel "	15 "	2,674	16,044
Steel plate, universal mill or rolled edge bridge plates, imported by manufacturers of bridges "	10 "	75,668	71,936
Steel in bars, bands, hoops, scroll or strips, sheets or plates, of any size, thickness or width, when of greater value than 2½c. per lb., N.O.P. "	5 "	73,779	250,032
Hoop iron, not exceeding three-eighths of an inch in width, and being No. 25 gauge or thinner, used for the manufacture of tubular rivets "	Free.	24	217
Iron or steel beams, sheets, plates, angles, knees and cable chains for wooden, iron, steel, or composite ships or vessels "	"	62,167	68,694
Locomotive and car wheel tires of steel, in the rough "	"	15,284	44,631
Steel for saws and straw cutters, cut to shape but not further manufactured "	"	10,410	66,263
Crucible sheet steel, 11 to 16 gauge, 2½ to 18 inches wide, imported by manufacturers of mower and reaper knives for manufacture of such knives in their own factories "	"	7,579	33,937
Steel of No. 20 gauge, and thinner, but not thinner than No. 30 gauge, to be used in the manufacture of corset steels, clock springs, and shoe shanks, imported by the manufacturers of such articles for exclusive use in the manufacture thereof in their own factories "	"	1,621	7,500
Steel valued at 2½c. per lb. and upwards, imported by the manufacturers of skates for use exclusively in the manufacture thereof in their own factories "	"	1,173	4,357
Carried forward			3,708,244

TABLE 9a—*Continued.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

IRON.

Imports.

Fiscal Year 1898.		Duty.	Quantity.	Value.
				$
Brought forward				3,708,244
Steel under ½ inch in diameter, or under ½ inch square, imported by the manufacturers of cutlery, or of knobs, or of locks, for use exclusively in the manufacture of such articles in their own factories	Cwt.	Free.	912	2,383
Steel of No. 12 gauge and thinner, but not thinner than No. 30 gauge, for the manufacture of buckle clasps, bed fasts, furniture casters, and ice creepers, imported by the manufacturers of such articles, for use exclusively in the manufacture thereof in their own factories	"	"	184	677
Steel of No. 24 and 17 gauge, in sheets 63 inches long and from 18 inches to 32 inches wide, imported by the manufacturers of tubular bow sockets for use in the manufacture of such articles in their own factories	"	"	1,183	2,595
Steel for International Bridge at Cornwall, O.C. Sept 29, 1897	Tons.	"	490	19,600
Steel for the manufacture of bicycle chain, imported by the manufactuers of bicycle chain for use in the manufacture thereof in their own factories	Cwt.	"	797	3,206
Steel for the manufacture of files, augers, auger bits, hammers, axes, hatchets, scythes, reaping hooks, hoes, hand rakes, hay or straw knives, windmills and agricultural or harvesting forks, imported by the manufacturers of such or any of such articles for use exclusively in the manufacture thereof in their own factories	"	"	44,598	77,460
Steel springs for the manufacture of surgical trusses, imported by the manufacturers for use exclusively in the manufacture thereof in their own factories	"	"	719	1,692
Steel for International Bridge at Niagara, O.C. July 8, 1896	"	"	644	1,287
Total				3,817,144

Table 9b.

Iron.

Imports of Iron and Steel Goods.

Iron.

Imports.

Fiscal Year 1898.		Duty.	Quantity.	Value.
				$
Agricultural implements, N.E.S., viz.:—				
Binding attachments	$	20 p. c.	....	7,824
Cultivators	No.	20 "	1,684	14,152
Drills, grain seed	"	20 "	2,220	54,382
Farm, road or field rollers	"	25 "	5	108
Forks, pronged	"	25 "	58,098	12,419
Harrows	"	20 "	3,561	36,156
Harvesters, self-binding and without binders	"	20 "	4,290	407,342
Hay tedders	"	25 "	1,793	801
Hoes	"	25 "	14,354	2,166
Horse rakes	"	20 "	1,973	31,578
Knives, hay or straw	"	25 "	348	128
" edging	"	25 "	....	....
Lawn mowers	"	35 "	1,556	4,770
Manure spreaders	"	20 "	2	175
Mowing machines	"	20 "	5,518	189,924
Ploughs	"	20 "	8,872	161,590
Post hole diggers	"	25 "	231	138
Potato diggers	"	25 "	10	69
Rakes, N.E.S.	"	25 "	5,464	1,126
Reapers	"	20 "	461	11,874
Scythes and snaths, sickles or reaping hooks	Doz.	25 "	5,948	22,857
Spades and shovels, and spade and shovel blanks, and iron or steel cut to shape for the same	"	35 "	4,631	16,623
Weeders	No.	20 "	88	127
All other agricultural implements, N.E.S.	$	25 "	....	13,834
All other agricultural implements, N.E.S., parts of	"	20 "	....	43,349
Anvils and vises	"	30 "	....	13,581
Cart or wagon skeins or boxes	Lbs.	30 "	1,450	229
Springs, axles, axle bars, N.E.S., and axle blanks, and parts thereof, of iron or steel, for railway or tramway or other vehicles.	Cwt.	35 "	10,749	28,554
Butts and hinges, N.E.S.	$	30 "	....	14,368
Cast iron pipe of every description	Cwt.	$8 per ton.	33,280	37,726
Chains, coil chain, chain links and chain shackles, of iron or steel, $\frac{5}{16}$ of an inch in diameter and over	Cwt.	5 p. c.	45,599	62,549
Chain, malleable sprocket or link belting for binders	$	20 "	....	19,866
Chains, N.E.S.	"	30 "	....	16,657
Tacks, shoe	Lbs.	35 "	27,356	2,534
Cut tacks, brads, sprigs or shoe nails, double pointed and other tacks of iron and steel, N.O.P.	"	35 "	139,049	8,609
Engines—				
Locomotives for railways, N.E.S.	No.	35 "	108	576,091
Fire	"	35 "	3	9,764
Fire extinguishing machines	"	35 "	9,591	9,481
Steam engines and boilers	"	25 "	739	100,327
Fittings, iron or steel, for iron or steel pipe.	Lbs.	30 "	1,893,308	85,523
Carried forward		....	....	2,019,371

Table 9b—*Continued.*

Iron.

Imports of Iron and Steel Goods.

Iron.

Imports.

Fiscal Year 1898.		Duty.	Quantity.	Value.
				$
Brought forward				2,019,371
Forgings of iron and steel, of whatever shape or size, or in whatever stage of manufacture, N.E.S.; and steel shafting, turned, compressed, or polished; and hammered iron or steel bars or shapes, N.O.P.	Lbs.	30 p. c.	1,284,391	34,844
Hardware, viz.: Builders', cabinetmakers', upholsterers', harness makers', saddlers', and carriage hardware, including curry combs, and horse boots, N.E.S.	$	30 "		423,354
Horse, mule, and ox shoes	"	30 "		5,470
Locks of all kinds	"	30 "		97,168
Machines and machinery, &c.:				
Fanning mills	No.	25 "	115	1,235
Grain crushers	"	25 "	2	37
Wind mills	"	25 "	378	16,749
Ore crushers and rock crushers, stamp mills, cornish and belted rolls, rock drills, air compressors, cranes, derricks and percussion coal cutters	$	25 "		38,589
Portable machines:—				
Fodder or feed cutters	No.	25 "		12
Horse powers	"	25 "	30	1,375
Portable engines	"	25 "	61	56,086
Portable saw mills and planing mills	"	25 "		9,707
Threshers and separators	"	25 "	134	38,002
All other portable machines	"	25 "		54,615
Parts of above articles	$	25 "		14,432
Sewing machines and parts of	No.	30 "	5,563	120,520
Slot machines	"	25 "	88	1,731
Machines, typewriting	"	25 "	1,158	64,064
All other machinery composed wholly or in part of iron or steel, N.O.P.	$	25 "		1,709,034
Nails and spikes, composition and sheathing nails	Lbs.	15 "	51,401	6,500
Nails and spikes, wrought and pressed, trunk clout, coopers, cigar box, Hungarian horse shoe and other nails, N.E.S.	"	30 "	204,958	7,896
Nails and spikes, cut and railway spikes	"	½c. per lb.	540,630	10,487
Nails, wire of all kinds, N.O.P.	"	⅗c. "	284,502	6,905
Pumps, N.E.S.	$	25 p. c.		93,550
Safes, doors for safes and vaults	"	30 "		6,651
Screws, iron and steel commonly called "wood screws," N.E.S.	Lbs.	35 "	105,371	10,502
Scales, balances, weighing beams and strength testing machines	$	30 "		42,160
Skates of all kinds and parts thereof	Pairs.	35 "	85,683	37,799
Stoves of all kinds and parts thereof, N.E.S.	$	25 "		88,778
Stove plates, and sad or smoothing, hatters' and tailors' irons, plated wholly or in part or not	$	25 "		7,213
Carried forward				5,024,836

TABLE 9b—*Continued.*

IRON.

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Imports.

Fiscal Year 1898.		Duty.	Quantity.	Value.
				$
Brought forward				5,024,836
Tubing—				
Boiler tubes of wrought iron or steel, including flues and corrugated tubes for marine boilers	Lbs.	5 p. c.	4,028,052	132,166
Tubes of rolled steel, seamless, not joined or welded, not more than $1\frac{1}{2}$ inches in diameter	"	10 "	273,221	15,186
Tubes, seamless steel, for bicycles	"	10 "	770,653	50,915
Tubing, wrought iron or steel, plain or galvanized, threaded and coupled or not, over 2 inches in diameter, N.E.S.	"	15 "	4,750,689	128,679
Tubing, wrought iron or steel, plain or galvanized, threaded and coupled or not, 2 inches or less in diameter, N.E.S.	"	35 "	9,511,503	216,956
Other iron or steel tubes, or pipes, N.O.P.	"	30 "	645,289	20,800
Ware—Galvanized sheet iron, or of galvanized sheet steel, manufactures of, N.O.P.	$	25 "		17,777
Ware—Agate, granite or enamelled iron or steel hollow ware	"	35 "		26,969
Ware—Enamelled iron or steel ware, N.E.S.; iron or steel hollow ware, plain black, tinned or coated; and nickel and aluminum kitchen or household hollow ware, N.E.S	"	30 "		57,218
Wire cloth, or wove wire and netting of iron or steel	Lbs.	30 "	227,880	12,203
Wire screens, doors and windows	$	30 "		2,349
Barbed wire and galvanized wire for fencing, No. 9, 12 and 13 gauge, to Jan. 1, 1898	Lbs.		1,814,371	28,673
Wire fencing, woven, buckthorn strip, and wire fencing of iron or steel, N.E.S.	"	15 p. c.	1,200,987	28,511
Wire, single or several, covered with cotton, linen, silk, rubber or other material, &c., N.E.S	"	30 "	1,514,082	211,197
Wire of all kinds, N.O.P.	"	20 "	6,056,559	127,353
Wire rope, stranded or twisted wire, clothes lines, picture or other twisted wire and wire cables, N.E.S	"	25 "	855,074	58,693
Iron or steel nuts, washers, rivets and bolts, with or without threads, and nut, bolt and hinge blanks, and T and strap hinges of all kinds, N.E.S.	"	$\frac{3}{4}$c. per lb. & 25 p.c.	2,037,880	68,991
Pen knives, jack knives and pocket knives of all kinds	$	30 p. c.		83,098
Table cutlery, all kinds, N.O.P	"	30 "		94,994
All other cutlery, N.E.S.	"	30 "		151,464
Guns, rifles, including air guns and air rifles, not being toys, muskets, cannons, pistols, revolvers, or other firearms	"	30 "		127,621
Bayonets, swords, fencing foils and masks.	"	30 "		3,770
Carried forward				6,690,119

TABLE 9b—*Continued.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

IRON.

Imports.

Fiscal Year 1898.		Duty.	Quantity.	Value.
				$
Brought forward				6,690,419
Needles of any material or kind, N.O.P.	$	30 p. c.		39,798
Surgical and dental instruments, to Dec. 31, 1897	$	10 "		21,395
Tools and implements :—				
Adzes, cleavers, hatchets, wedges, sledges, hammers, crowbars, cant dogs and track tools, picks, mattocks and eyes or poles for the same	$	30 "		37,597
Axes	Doz.	25 "	9,006	36,593
Saws	$	30 "		81,148
Files and rasps, N.E.S	"	30 "		73,211
Tools, hand or machine, of all kinds, N.O.P.	"	30 "		365,362
Knife blades or blanks, and forks of iron or steel, in the rough, not handled, filed, ground or otherwise manufactured		10 "		1,095
Manufactured articles or wares not specially enumerated or provided for, composed wholly or in part of iron or steel, and whether partly or wholly manufactured.	$	30 "		765,032
Anchors	Cwt.	Free.	2,493	8,990
Iron or steel, rolled round wire rods, in the coil, not over $\frac{3}{8}$ inch in diameter, imported by wire manufacturers for use in making wire in their own factories	"	"	671,773	658,153
Rolled iron tubes not welded or joined, under $1\frac{1}{2}$ inch in diameter, angle iron 9 and 10 gauge, not over $1\frac{1}{2}$ inch wide, iron tubing lacquered or brass covered, not over $1\frac{1}{2}$ inch diameter, all of which are to cut to lengths for the manufacture of bedsteads, and to be used for no other purpose, and brass trimmings for bedsteads imported for the manufacture of iron or brass bedsteads	Cwt.	"	49,493	57,502
Steel bowl for cream separators and cream separators	$	"		133,052
Steel rails weighing not less than 45 lbs. per lineal yard, for use only in tracks of railways which are employed in the common carrying of goods and passengers and are operated by steam motive power only	Cwt.	"	2,103,562	1,810,605
Steel strip and flat steel wire imported by manufacturers of buckthorn, and plain strip fencing, for use in their own factories in the manufacture thereof; and barbed wire fencing of iron or steel after Jan. 1, 1898	"	"	131,734	212,485
Carried forward				10,992,437

Iron.

Imports.

TABLE 9b—*Continued.*

IRON.

IMPORTS OF IRON AND STEEL GOODS.

Fiscal Year 1898.		Duty.	Quantity.	Value.
				$
Brought forward..		....	....	10,992,437
Steel wire, Bessemer soft drawn spring, of Nos. 10, 12 and 13 gauge, respectively, and homo steel spring wire of Nos. 11 and 12 gauge, respectively, imported by manufacturers of wire mattresses, to be used in their own factories in the manufacture of such articles	"	"	13,014	22,630
Flat steel wire of No. 16 gauge or thinner, imported by the manufacturers of crinoline or corset wire and dress stays, for use in the manufacture of such articles in their own factories	"	"	2,891	13,264
Flat spring steel, still billets and steel axle bars, imported by manufacturers of carriage springs and carriage axles for use exclusively in the manufacture of springs and axles for carriages or vehicles, other than railway or tramway, in their own factories	"	"	36,492	51,113
Spiral spring steel for spiral springs for railways, imported by the manufacturers of railway springs for use exclusively in the manufacture of railway spiral springs in their own factories	"	"	16,944	26,536
Wire, crucible cast steel	Lbs.	"	626,225	32,306
Galvanized iron or steel wire Nos. 9, 12 and 13 gauge, after Jan. 1, 1898	Cwt.	"	153,392	234,821
Total		....	....	11,373,107

TABLE 10.

IRON.

IMPORTS OF PIG IRON, IRON AND STEEL GOODS, ETC., FISCAL YEAR 1897-8.
RECAPITULATION OF TABLES 6, 7, 8, 9a AND 9b.

——	Tons.	Value.
Pig-iron and iron kentledge	37,186	$382,103
" charcoal	2,250	23,533
Scrap iron, cast	1,559	13,251
" steel, wrought	48,903	534,577
Ferro-manganese, etc	1,418	22,516
Iron in slabs, blooms, puddled bars, etc	8,144	122,426
Iron and steel goods, partially manufactured	....	3,817,144
" " highly manufactured*	....	11,373,107
Total	....	16,288,657

* Machinery etc., classed under iron and steel goods in Customs report.

The iron industries of Canada are so well and pithily described in the Annual Statistical Report of the American Iron and Steel Association for 1898 that their remarks are below reproduced in full:— IRON.

'On December 31, 1898, the unsold stocks of pig-iron in Canada which were in the hands of the manufacturers or their agents amounted to 9,979 tons, as compared with 20,265 tons on December 31, 1897, 29,320 tons on December 31, 1896, and 17,800 tons on December 31, 1895. On the unsold pig-iron on hand on December 31, 1898, about four-fifths was charcoal pig-iron, the remainder being coke iron.

'Canada did not produce any spiegeleisen or ferro-manganese in 1897 or 1898, although some time ago the Mineral Products Company of Hillsborough, New Brunswick, leased the Bridgeville furnace at Bridgeville, Nova Scotia, for this purpose, and expected to have the furnace in operation in 1898. The company now hopes to blow in the furnace some time in May. The ferro-manganese will be made from briquettes of manganese ore. The annual capacity of the furnace is about 7,300 gross tons.

'On December 31, 1898, there were 9 completed blast furnaces in the Dominion, and of this number 3 were in blast and 6 were out of blast on the date named. On December 31, 1897, there were 8 completed blast furnaces, of which 4 were in blast and 4 were idle. In the spring of 1898 the Deseronto Iron Company, Limited, began building a charcoal furnace at Deseronto, in the province of Ontario, which it completed in December. The furnace was blown in on January 25, 1899. It is now making about 1,000 tons of pig-iron per month from Lake Superior ores.

'The production of crude steel, steel castings, and all kinds of iron and steel rolled into finished forms in Canada in 1898 is given approximately below, full reports or careful estimates having been received by us from all the manufacturers in the Dominion.

'The production of Bessemer and of basic and acid open-hearth steel ingots and castings in 1898 was 21,540 gross tons, against 18,400 tons in 1897, 16,000 tons in 1896, and 17,000 tons in 1895. Of the total production of open-hearth steel in 1898 a little more than one-half was made by the acid process. The production of open-hearth steel rails in 1898 amounted to 600 tons, against 500 tons in 1897; structural shapes, 1,565 tons, against 4,300 tons in 1897; cut nails made by rolling mills and steel works having cut-nail factories connected with their plants, 152,688 kegs of 100 pounds, against 202,939 kegs in 1897; plates and sheets, about 1,000 tons, against about 2,000 tons in 1897; all other rolled products, excluding muck and scrap bar,

IRON.

blooms, billets, sheet bars, etc., 80,322 tons against 61,161 tons in 1897. Changing the cut nail production from kegs of 100 pounds to gross tons of 2,240 pounds, the total quantity of all kinds of iron and steel rolled into finished products in the Dominion in 1898, excluding muck and scrap bar, billets, and other intermediate products, amounted to 90,303 tons, against 77,021 tons in 1897, 75,043 tons in 1896, and 66,402 tons in 1895.

'The total number of rolling mills and steel works in Canada on December 31, 1898, was 18. Of this number at least 4 were idle during the whole of 1898. Canada has only one steel casting plant, which is equipped with a 3,000 pound modified acid Bessemer converter. Its first castings were produced in 1897. Canada has also one open-hearth steel plant, which makes steel by both the acid and basic processes.'

LEAD.

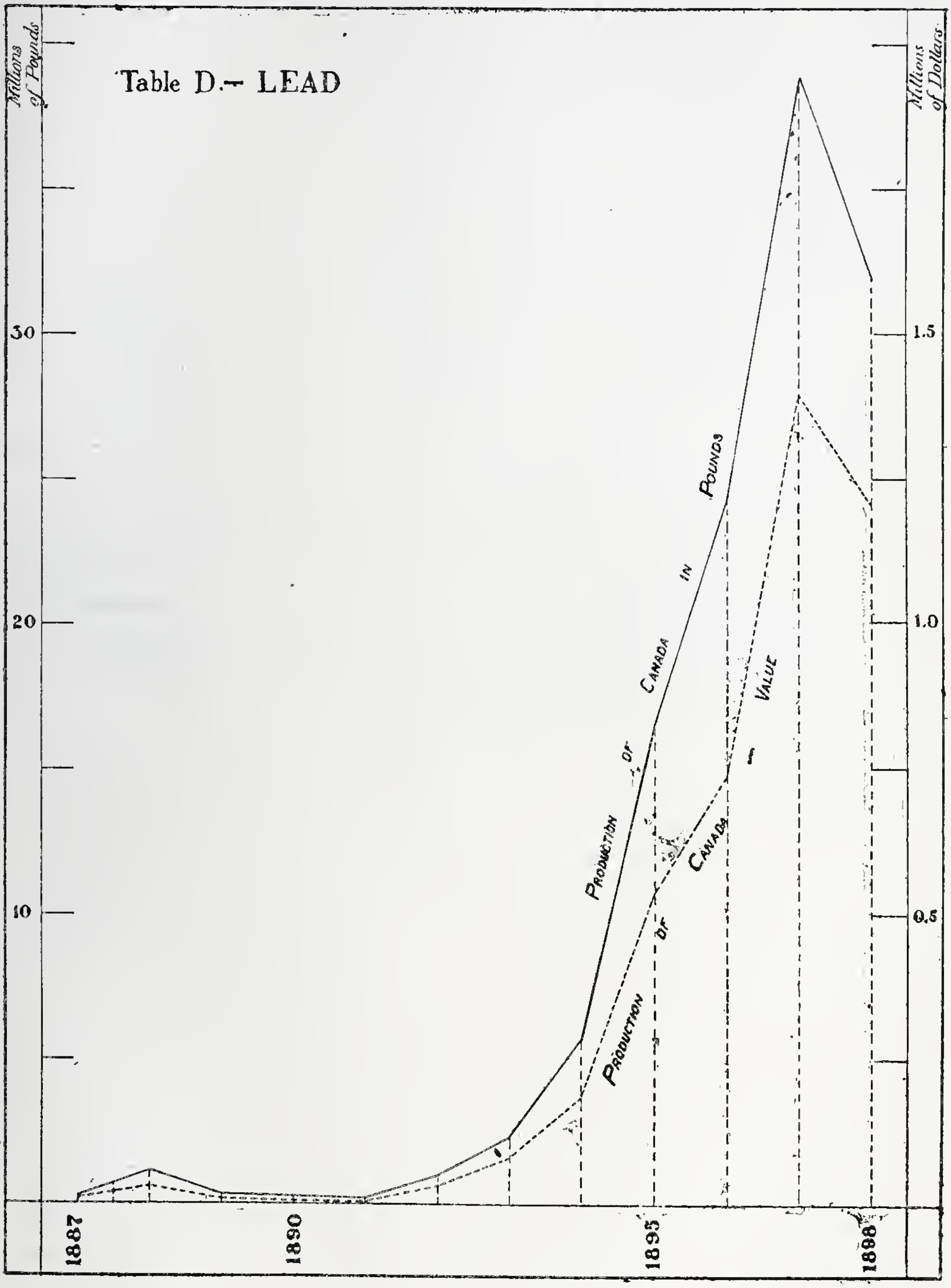
LEAD.

Production.

There were but two metals which showed a decrease in production in 1898 when compared with 1897, viz., silver and lead. Almost the whole of the production of lead and a very large proportion of the silver is derived from the argentiferous galena ores of the Ainsworth and Slocan divisions of West Kootenay, British Columbia, and the total shipments of ore from these divisions were less in 1898 than in 1897. The reasons given for this decrease were, the low price of silver in the early part of the year and the uncertainty as to its future value. It was also stated that a number of the larger shippers were restricting their output in the hope that with the completion of the Crow's Nest Pass railway cheaper freight rates and fuel would be obtained.

The total production of lead in 1898 was 31,915,319 lbs., valued at $1,206,399, or 3·78c. per lb., the average market price for the metal for the year in New York. Compared with 1897 this is a decrease of 7,102,900 lbs. or 18·2 per cent in quantity, and $190,454 or 13·63 per cent in value, but, at the same time, it is greater than the production of 1896 by nearly 32 per cent.

The variations in the production of lead are shown graphically in Table D below while the figures are given in Table 1.



Lead.

Table 1.

Lead.

Production.

Annual Production.

Calendar Year.	Pounds.	Price per Pound.	Value.
		c.	
1887	204,800	4·50	$ 9,216
1888	674,500	4·42	29,813
1889	165,100	3·93	6,488
1890	105,000	4·48	4,704
1891	88,665	4·35	3.857
1892	808,420	4·09	33,064
1893	2,135,023	3·73	79,636
1894	5,703,222	3·29	187,636
1895	16,461,794	3·23	531,716
1896	24,199,977	2·98	721,159
1897	39,018,219	3·58	1,396,853
1898	31,915,319	3·78	1,206,399

The value of the exports of lead as furnished by the Customs Department is shown in Table 2. Although all the lead is exported, no comparison is possible betwen Tables 1 and 2, owing to the different basis of valuation adopted in the two tables. In exporting, the shippers value the lead at its spot value in the ore at the point of export, while in the table of production the lead is valued at the full and final market price of the metal.

TABLE 2.

LEAD.

EXPORTS.

LEAD.

Exports.

Calendar Year.	Value.
1873	$ 1,993
1874	127
1875	7,510
1876	66
1877	720
1878	....
1879	230
1880	....
1881	....
1882	32
1883	5
1884	36
1885	....
1886	....
1887	724
1888	18
1889	....
1890	....
1891	5,000
1892	2,509
1893	3,099
1894	144,509
1895	435,071
1896	462,095
1897	925,144
1898 Quebec	600
1898 North-west Territories	1,585
1898 British Columbia	883,300
Total, 1898	885,485

LEAD.

The imports of lead are shown in Tables 3 and 4, and are the largest since 1890.

TABLE 3.

LEAD.

Imports.

IMPORTS OF LEAD.

Fiscal Year.	Old, Scrap and Pig.		Bars, Blocks, Sheets.		Total.	
	Cwt.	Value.	Cwt.	Value.	Cwt.	Value.
1880	....	... .	....	....	30,298	$124,117
1881	16,236	$ 56,919	18,222	$70,744	34,458	127,663
1882	36,655	120,870	10,540	35,728	47,195	156,598
1883	48,780	148,759	8,591	28,785	57,371	177,544
1884	39,409	103,413	9,704	28,458	49,113	131,871
1885	36,106	87,038	9,362	24,396	45,468	111,434
1886	39,945	110,947	9,793	28,948	49,738	139,895
1887	61,160	173,477	14,153	41,746	75,313	215,223
1888	68,678	196,845	14,957	45,900	83,635	242,745
1889	74,223	213,132	14,173	43,482	88,396	256,614
1890	101,197	283,096	19,083	59,484	120,280	342,580
1891	86,382	243,033	15,646	48,220	102,028	291,253
1892	97,375	254,384	11,299	32,368	108,674	286,752
1893	94,485	215,521	12,403	32,286	106,888	247,807
1894	70,223	149,440	8,486	20,451	78,709	169,891
1895	67,261	139,290	6,739	16,315	74,000	155,605
1896	72,433	173,162	8,575	23,169	81,008	196,331
1897	65,279	158,381	10,516	29,175	75,795	187,556
	Old, Scrap, Pig and Block.*		Bars and Sheets.†		Total.	
1898	84,420	$260,779	22,214	$39,041	110,634	$299,820

* Duty 15 p. c.

† Duty 25 p. c.

Lead.

Imports.

TABLE 4.

LEAD.

IMPORTS OF LEAD MANUFACTURES.

Fiscal Year.		Value.
1880		$15,400
1881		22,629
1882		17,282
1883		25,556
1884		31,361
1885		36,340
1886		33,078
1887		19,140
1888		18,816
1889		16,315
1890		25,600
1891		23,893
1892		22,636
1893		33,783
1894		29,361
1895		38,015
1896		50,722
1897		60,735
	Duty.	
1898 Lead, Tea	Free.	$27,721
1898 " Pipe	35 p. c.	4,068
1898 " Shot and bullets	35 "	1,402
1898 " Manufactures, N.E.S.	30 "	29,988
Total		$63,179

TABLE 5.

LEAD.

IMPORTS OF LITHARGE.

Fiscal Year.	Cwt.	Value.
1880	3,041	$14,334
1881	6,126	22,129
1882	4,900	16,651
1883	1,532	6,173
1884	5,235	18,132
1885	4,990	16,156
1886	4,928	16,003
1887	6,397	21,865
1888	7,010	23,808
1889	8,089	31,082
1890	9,453	31,401
1891	7,979	27,613
1892	10,384	34,343
1893	7,685	24,401
1894	38,547	28,685
1895	11,955	32,953
1896	10,710	32,817
1897	12,028	34,538
1898 ... Duty free.	11,446	32,904

Lead.

British Columbia.

As stated before, lead mining was almost entirely limited to British Columbia, the only other work of any importance being that carried on by the Grand Calumet Mining Co., Limited, on their blende and galena deposits on Calumet Island in Quebec. About 1,100 tons of ore were taken out and shipped to Belgium.

The production in British Columbia is shown in Table 6, following.

Table 6.

Lead.

British Columbia : Production.

Calendar Year.	Pounds.	Price per Pound.	Value.
		cts.	
1887	204,800	4·50	$ 9,216
1888	674,500	4·42	29,813
1889	165,100	3·93	6,488
1890	Nil.	....	....
1891	"	....	....
1892	808,420	4·09	33,064
1893	2,131,092	3·73	79,490
1894	5,703,222	3·29	187,636
1895	16,461,794	3.23	531,716
1896	24,199,977	2·98	721,159
1897	38,841,135	3·58	1,390,513
1898	31,693,559	3·78	1,198,017

The production of 1898 was less by 7,147,576 lbs. than the production of 1897, a decrease of 18 per cent. The proportions contributed by the various districts were as follows :—Fort Steele division of Kootenay East, 7·21 per cent ; Ainsworth and Slocan divisions of Kootenay West, 6·24 per cent and 85·59 per cent, respectively.

In the Fort Steele division a large amount of prospecting and development work has been done, the results of which will probably become apparent in the immediate future. The North Star and St. Eugene mines are two properties which have undergone the largest amount of development. The ore of the former is said to average 50 ozs. of silver, and 50 per cent lead. Operations in the Ainsworth division were also largely confined to development work.

In the Slocan, the chief lead producing district, there were about twenty shipping mines of which six shipped over 1,000 tons of ore each. The total shipments were 30,691 tons and the ore averaged about 44 per cent lead. The average lead contents of the ore were about the same as the previous year, but the shipments were nearly 3,000 tons less.

MANGANESE.

MANGANESE.

Production.

Manganese ores have been produced to some extent in the provinces of Nova Scotia and New Brunswick, but since 1890 the production has greatly fallen off. Excluding the ore mined by the Mineral Products Company at Dawson Settlement in New Brunswick, which was not shipped during the year but remained as stock in hand, the production for 1898 was 50 tons, valued at $1,600.

The production of past years has varied very much in the grade of ore shipped, as is evidenced by the changes in the average value per ton of the different years' productions.

TABLE 1.

MANGANESE.

ANNUAL PRODUCTION.

Calendar Year.	Tons.	Value.	Value per ton.
1886....	1,789	$41,499	$23.20
1887.................	1,245	43,658	35.07
1888.................	1,801	47,944	26.62
1889.................	1,455	32,737	22 50
1890.................	1,328	32,550	24.51
1891.................	255	6,694	26.25
1892................	115	10,250	89.13
1893.................	213	14,578	68.44
1894.................	74	4,180	56.49
1895.................	125	8,464	67.71
1896*................	123½	3,975	32.19
1897*	15¼	1,166	76.46
1898	50	1,600	32.00

* Exports.

Manganese.

TABLE 2.

MANGANESE.

EXPORTS OF MANGANESE ORE.

Exports.

Calendar Year.	Nova Scotia.		New Brunswick.		Total.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
1873	....	....	1,031	$20,192	1,031	$20,192
1874	6	$ 12	776	16,961	782	16,973
1875	....	200	194	5,314	203	5,514
1876	21	723	391	7,316	412	8,039
1877	106	3,699	785	12,210	891	15,909
1878	106	4,889	520	5,971	626	10,860
1879	154	7,420	1,732	20,016	1,886	27,436
1880	79	3,090	2,100	31,707	2,179	34,797
1881	200	18,022	1,504	22,532	1,704	40,554
1882	123	11,520	771	14,227	894	25,747
1883	313	8,635	1,013	16,708	1,326	25,343
1884	134	1,054	469	9,035	603	20,089
1885	77	5,054	1,607	29,595	1,684	34,649
1886	(a) 441	854	1,377	27,484	(a)1,818	58,338
1887	578	14,240	837	20,562	1,415	34,802
1888	87	5,759	1,094	16,073	1,181	21,832
1889	59	3,024	1,377	26,326	1,436	29,350
1890	177	2,583	1,729	34,248	1,906	36,831
1891	22	563	233	6,131	255	6,694
1892	84	6,180	59	2,025	143	8,205
1893	123	12,409	10	112	133	12,521
1894	11	720	45	2,400	56	3,120
1895	108	6,348	$\frac{3}{10}$	3	108$\frac{3}{10}$	6,351
1896	123½	3,975	....	....	123½	3,975
1897	15¼	1,166	....	....	15¼	1,166
1898	11	325	....	....	11	325

(a) 250 tons from Cornwallis should more correctly be classed under the heading of mineral pigments.

TABLE 3.

MANGANESE.

IMPORTS: OXIDE OF MANGANESE.

Fiscal Year.	Pounds.	Value.
1884	3,989	$ 258
1885	36,778	1,794
1886	44,967	1,753
1887	59,655	2,933
1888	65,014	3,022
1889	52,241	2,182
1890	67,452	3,192
1891	92,087	3,743
1892	76,097	3,530
1893	94,116	3,696
1894	101,863	4,522
1895	64,151	2,781
1896	108,590	4,075
1897	70,663	2,741
1898, ...Duty free	130,456	5,047

In Nova Scotia work was continued at the New Ross deposit, Lunnenburg county, by Mr. Miner T. Foster, of Halifax, and a quantity of high-grade ore was shipped to New York. MANGANESE.

In New Brunswick at the Jordan Mountain mine, in Kings county, six men were employed for about two months sinking a shaft and taking out ore. The vein was cut 26 feet from the top and found 8 feet thick. About 30 tons of ore were taken out but none was shipped.

Active operations were continued at the deposit of bog manganese at Dawson Settlement, near Hillsborough, by the Mineral Products Company of New York. The mode of occurrence and analyses of the ore at this deposit were given in the Report for 1897. The following description of the property and works is given by Mr. Russel P. Hoyt, the general manager of the company. Hillsborough, N.B.

'This manganese ore is of the kind known as "wad" and occurs under a thin coating of soil or vegetable matter down to the underlying clay, and is of a varying thickness extending to a depth of from 5 to 30 feet covering an area of 17 acres. The material is so soft that it can be shovelled up without blasting or aid of a pick and requires no timbering and can be mined for less than 20 cents per ton. The deposit lies on a hillside with a slightly higher elevation behind it, and a deep gully running along its base. The "wad" ore in its natural state contains about 50 per cent of water which of course must be eliminated. The ore is dumped into the feed-hopper of a dryer, which is a brick chamber 10 by 14 feet and 30 feet high, in which there is a revolving cylinder of ½ in. iron, 5 feet in diameter and 28 feet long, heated by wood or coal. The material dried is a fine powder like flour and when put into a blast furnace will immediately fly out. The material from the dryer is drawn into a mixer where it is mixed with a suitable "binder" the purpose of which is to cement the powdered ore together. The mixed ore is then conveyed up to a sufficient height to pass in at the top of a briquetting machine and comes out in the form of a hard cylindrical brick 3 in. in diameter and 2½ in. long, the pressure being 2,000 lbs. to the inch.

'These briquettes are then loaded into box cars at the mill and transported without change of bulk to Bridgeville, Nova Scotia, and there manufactured into ferro-manganese at the blast furnace works of our company.'

About 3,000 tons of ore were mined during the year of which 600 were treated at the mill.

Mercury.

MERCURY.

There was no production of mercury reported for 1898. The small output of the past three years was obtained from the Cinnabar mines in the vicinity of Kamloops Lake, B.C., and the following report on these deposits is taken from the report of the Minister of Mines for British Columbia.

Development in British Columbia.

'No work has been done on any of the claims of the Cinnabar Mining Company for the past season. It is a matter of regret that these properties have been so long idle, the money spent on them having been lavished on the more unpromising locations, and in building of a furnace not suited for such ore, as is shown by the fact that quicksilver can be panned anywhere in the gulch below the furnace. This loss is only a fraction of that which took place in the air as shown by the quicksilver in the flues. Mr. H. L. Lightner, ex-superintendent of the company's mines on Kamloops Lake, has lately made a thorough investigation of the mine and furnace, in the interests of the Cinnabar Company, with a view of making changes and commencing work at an early date on a firm business basis.'

Work has been done during the season on some of the most promising prospects as follows :—

'*Columbia Mineral Claim.*—Sixty feet of tunnel and 40 feet open cuts on the dykes. The cross-cut in the tunnel shows up a good body of furnace ore, assaying $1\frac{1}{2}$ to 2 per cent quicksilver. Work will be continued during the winter driving the tunnel ahead on the dyke, developing the claim and assisting the drainage of the upper benches.

'*Almaden Mineral Claim.*—Development consists of 60 feet of shafts and open cuts. The prospect is good for a large body of furnace ore.

'*Idria Mineral Claim.*—Fifty feet of shafts and open cuts for season's work, have been done on the dykes, water interfering with sinking. Further opening of the tunnel on the Columbia will have the effect of draining this claim so that work can be dono much earlier next season.

'*Martell Mineral Claim.*—Mr. A. Hardie is at present engaged in running a tunnel to intersect the dyke from the present showing on the surface. More or less work will be done during the winter.

'Work on other Cinnabar locations on the mountain this season consisted merely of superficial prospect holes, with not enough work done to warrant an opinion. In June last, a very promising outcropping of Cinnabar was discovered on Three mile Creek, by H. I. Colquhoun,

15 miles south of Savona, proving the southward continuation of the quicksilver belt. Work will be done on this property in the early spring.' Mercury.

The following statistics are available regarding production and imports.

Table 1.

Mercury.

Production. Production.

Calendar Year.	Flasks, (76½ lbs.)	Price per flask.	Value.
1895	71	$ 33 00	$ 2,343
1896	58	33 44	1,940
1897	9	36 00	324

Table 2.

Mercury.

Imports. Imports.

Fiscal Year.	Pounds.	Value.
1882	2,443	$ 965
1883	7,410	2,991
1884	5,848	2,441
1885	14,490	4,781
1886	13,316	7,142
1887	18,409	10,618
1888	27,951	14,943
1889	22,931	11,844
1890	15,912	7,677
1891	29,775	20,223
1892	30,936	15,038
1893	50,711	22,998
1894	36,914	14,483
1895	63,732	25,703
1896	77,869	32,343
1897	76,058	33,534
1898	59,759	36,425

MICA.

MICA.

Accurate statistics of mica production are difficult to obtain, there being so many small deposits worked in a quiet way and often intermittently.

In calculating the production the practice of the past few years has been followed namely of adding to the known exports an estimate of the value of the home consumption. These values (the export values) are, however, believed to be considerably underestimated, hence the figures given below are probably much below the actual production.

Production.

TABLE 1.

MICA.

ANNUAL PRODUCTION.

Calendar Year.	Value.
1886	$ 29,008
1887	29,816
1888	30,207
1889	28,718
1890	68,074
1891	71,510
1892	104,745
1893	75,719
1894	45,581
1895	65,000
1896	60,000
1897	76,000
1898	118,375

Exports.

TABLE 2.

MICA.

EXPORTS.

Calendar Year.	Value.
1887	$ 3,480
1888	23,563
1889	30,597
1890	22,468
1891	37,590
1892	86,562
1893	70,081
1894	38,971
1895	48,525
1896	47,756
1897	69,101
1898	110,507

The figures show a considerable extension of the mica mining industry in 1898. The value of the production for this year being greater than that of 1897 by $42,375 or an increase of 55 per cent. Mica.

With the exception of the developments prosecuted at Tête Jaune Cache, in British Columbia, the mining of mica has been, as usual carried on chiefly in the district around Ottawa. The deposits worked occur in the Laurentian rocks and the mica produced is practically all phlogopite.

Tête Jaune Cache, B.C.

In British Columbia some work has been done, as stated, in the vicinity of Tête Jaune Cache, about 150 miles north-west of Donald, on the Canadian Pacific Railway, at the head waters of the Fraser River. A short description of the occurrences in this vicinity has been given by Mr. McEvoy in the Summary Report of the Director of the Geological Survey for 1898 (p. 80.)

According to this authority the mica occurs as a constituent of coarse pegmatite veins which cut the rocks of the district. 'These consist of garnetiferous mica-schists and gneisses with some blackish micaceous schists and light-coloured gneisses that represent foliated granitoid rock. The garnet-mica-schist is the predominating rock.

'On one of these veins the Bonanza mica claim is located seven miles south of Tête Jaune Cache, 5,300 feet above the level of the Fraser River. The vein is about fifteen feet wide, where an opening has been made, dipping S. 45° W., conformably with the country rock . . . . At the time of our visit Messrs. S. Winter and J. F. Smith with a party of ten men, were engaged in taking out and cutting mica intended for shipment by pack-horses to the nearest railway point. The quartz, felspar and mica are separated into large masses, the crystals of mica being frequently eighteen inches long and eleven inches wide and are found in greatest abundance near the hanging wall . . . . The mica is a transparent muscovite with a very light-greenish cast and is otherwise of excellent quality. The probabilities of further important developments appear to be very favourable.

'Another claim owned by some Edmonton miners is situated a few miles south-east of the Bonanza. Fifteen miles to the south-east on the mountains, near the head waters of the Canoe River, several claims have also been staked. On one of these some work is reported to have been done, exposing a deposit of marketable mica. It may be expected that further discoveries of valuable mica deposits will be made in these rocks which are of the same character for a distance of twenty miles at least and probably much further.'

A great hindrance to the development of this or any other mining industry in this part of the country is the lack of proper trails and the expense of the only means of transport available, viz., by pack trains.

Mineral Pigments.

MINERAL PIGMENTS.

The only production to report under this heading is that of ochres and baryta.

Production of Ochres.

Ochres.—The production of ochres in 1898 amounted to 2,226 tons, valued at $17,450, a decrease of nearly 43 per cent in quantity from the production of the previous year.

With the exception of a small shipment from the township of Nelson, Halton county, Ontario, the production is entirely from the ochre deposits near Three Rivers, Champlain county, Quebec. Both the Canada Paint Company and the Champlain Oxide Company working in this district have grinding mills and kilns for calcining the ochre. Thos. Argall did no actual mining during the year, but shipped from stock on hand.

TABLE 1.

MINERAL PIGMENTS.

ANNUAL PRODUCTION OF OCHRES.

Calendar Year.	Tons.	Value.
1886	350	$ 2,350
1887	485	3,733
1888	397	7,900
1889	794	15,280
1890	275	5,125
1891	900	17,750
1892	390	5,800
1893	1,070	17,710
1894	611	8,690
1895	1,339	14,600
1896	2,362	16,045
1897	3,905	23,560
1898	2,226	17,450

MINERAL PIGMENTS.

TABLE 2.
MINERAL PIGMENTS.
IMPORTS OF OCHRES.

Imports of Ochres.

Fiscal Year.		Pounds.	Value.
1880		571,454	$ 6,544
1881		677,115	8,972
1882		731,526	8,202
1883		898,376	10,375
1884		533,416	6,398
1885		1,119,177	12,782
1886		1,100,243	12,267
1887		1,460,128	17,067
1888		1,725,460	17,664
1889		1,342,783	12,994
1890		1,394,811	14,066
1891		1,528,696	20,550
1892		1,708,645	22,908
1893		1,968,645	23,134
1894		1,358,326	18,951
1895		793,258	12,048
1896		1,159,494	16,954
1897		1,504,044	18,504
	Duty.		
1898. Ochres and ochrey earths and raw siennas	20 p. c.	987,650	$ 9,428
1898. Oxides, dry fillers, fire-proofs, umbers and burnt siennas, N.E.S.	25 "	1,138,942	16,879
Total, 1898	....	2,126,592	$26,307

Baryta.—The production of baryta is shown in Table 3, the figures for 1898 being 1,125 tons, valued at $5,533, nearly twice the production of the previous year.

TABLE 3.
MINERAL PIGMENTS.
ANNUAL PRODUCTION OF BARYTA.

Production of Baryta.

Calendar Year.	Tons.	Value.
1885	300	$ 1,500
1886	3,864	19,270
1887	400	2,400
1888	1,100	3,850
1889	....	....
1890	1,842	7,543
1891	....	....
1892	315	1,260
1893	....	....
1894	1,081	2,830
1895	....	....
1896	145	715
1897	571	3,060
1898	1,125	5,533

Mineral Pigments.

The deposit at Lake Ainslie, Cape Breton county, Nova Scotia, was worked to some extent and the baryta shipped by boat from Whycocomagh.

In Quebec the Canada Paint Company took out a number of tons from a deposit on the Foley farm, lot 10, con. VII. of Hull, Wright county.

Imports of Baryta.

TABLE 4.

MINERAL PIGMENTS.

IMPORTS OF BARYTA.

Fiscal Year.	Cwt.	Value.
1880	2,230	$1,525
1881	3,740	1,011
1882	497	303
1883	....	185
1884	....	229
1885	7	14
1886	....	62
1887	379	676
1888	236	214
1889	1,332	987
1890	1,322	978

Micellaneous Imports.

TABLE 5.

MINERAL PIGMENTS.

MISCELLANEOUS IMPORTS, FISCAL YEAR, 1898.

—		Duty.	Quantity.	Value.
				$
Paint, ground or mixed in, or with either japan, varnish, lacquers, liquid dryers, collodion, oil finish or oil varnish	Lbs.	25 p. c.	35,304	2,870
Paints and colours, and rough stuff and fillers, anti-corrosive and anti-fouling paints commonly used for ship hulls, N.E.S	"	25 "	83,053	3,034
Paris green, dry	"	10 "	296,151	33,342
Paints and colours ground in spirits, and all spirit varnishes and lacquers	Galls.	$1.12½ per gallon	589	1,925
Putty	Lbs.	20 p. c.	370,231	4,730
Total		....	....	45,901

MINERAL WATER.

MINERAL WATER.

Mineral waters are produced to some considerable extent at various points in New Brunswick and Ontario, although the springs at present of greatest commercial value are probably those of the Radnor Mineral Water Company and the St. Leon Mineral Water Company, situated in the province of Quebec. No returns of production have been received recently from the latter company, and we have therefore been compelled to estimate to a certain extent the total production. The figures of production given for the year, viz.: 555,000 gallons, valued at $100,000, may perhaps therefore be too low, though we believe they represent to a fairly accurate degree the truth.

TABLE 1.

MINERAL WATERS.

ANNUAL PRODUCTION.

Production.

Calendar Year.	Gallons.	Value.
1888	124,850	$ 11,456
1889	424,600	37,360
1890	561,165	66,031
1891	427,485	54,268
1892	640,380	75,348
1893	725,096	108,347
1894	767,460	110,040
1895	739,382	126,048
1896	706,372	111,736
1897	749,691	141,477
1898	555,000	100,000

Mineral Water.

Imports.

TABLE 2.

MINERAL WATERS.

IMPORTS.

Fiscal Year.	Value.
1880	$15,721
1881	17,913
1882	27,909
1883	28,130
1884	27,879
1885	32,674
1886	22,142
1887	33,314
1888	38,046
1889	30,343
1890	40,802
1891	41,797
1892	55,763
1893	57,953
1894	49,546
1895	48,613
1896	55,864
1897	47,006
1898 { Mineral waters, natural, not in bottles... ....Duty free ..	$ 865
Mineral and aerated waters, N.E.S.......... .... " 20 p.c.	52,124
	$52,989

Natural Gas.

NATURAL GAS.

The total value of the natural gas sold in 1898 was $322,123. The gas is all obtained from the wells in southern Ontario, the natural gas of the North-west Territories not yet having been put to use.

In the Welland field, the greater part of the gas from which is sold in Buffalo, by the Provincial Natural Gas Co., the value of the output was $100,364. There were five other small companies supplying gas locally.

In the Essex field, the Natural Gas and Oil Co. is the largest producer and exports most of its product to Detroit. The towns of Leamington and Kingsville have their own municipal natural gas plants, and the Kingsville Natural Gas Co., which sold out the principal part of its plant to the municipality of Kingsville, supplies the village of Ruthven. The total value of the production in this field was $221,759.

Table 1, below, shows the value of the production of natural gas for the past seven years. NATURAL GAS.

TABLE 1.

NATURAL GAS.

ANNUAL PRODUCTION. Production.

Calendar Year.	Value.
1892	$ 150,000
1893	376,233
1894	313,754
1895	423,032
1896	276,301
1897	325,873
1898	322,123

ONTARIO.

Mr. T. Denis made a short visit to the gas fields and furnishes the following notes of his observations :—

Essex County.—The main producing gas area of Essex county comprises the south-eastern part of Gosfield township and the adjoining south-western part af Mersea township, along the shore of Lake Erie.

The general level of the country is 20 to 40 feet above the lake. The rocks show a decided rise towards the shore, the dip being north.

In this area gas is found at a depth of from 1,000 to 1,020 feet, in a vesicular calcareous dolomite. If boring be carried down deeper, to 1,050 or 1,100 feet, operations are impeded and wells flooded by heavy flows of salt water, invariably struck below the gas horizon. The production of each well seems to depend very much on the porosity of the rock at that place, increasing with it. In almost every case there are also slight shows of oil at that depth.

This field was first opened in 1891, at which time the rock-pressure was about 400 lbs. The average is claimed to be yet 350 lbs., after having drawn on this natural reservoir for several years, which tends to show that the field has been very ably handled. The companies which commenced work in this field seem to have benefitted by the experience of the Ohio gas fields, where such a waste was indulged in that the accumulation of gas was soon exhausted. Moreover, the enactment of the Ontario government, in 1892, of an Act regulating the exploitation of gas fields, intended to prevent waste, had a very beneficial effect in lengthening the life of the territory. At present the field is well managed, systematically and economically, and the

Natural Gas.

best results are being obtained from the natural underground gas reservoir, as far as the interests of the companies are concerned.

The largest flow from an individual well in this field was noticed near the southern limit of lot 11, con. I, which is about the centre of the area. This well registered an open pressure of 45 lbs., through an opening of 3 inches in diameter, which is equal to a flow of over 9,000,000 cubic feet per twenty-four hours.

Besides the gas area on the lake shore, a small field has been struck in Mersea township, to the north of the larger field. Three flowing wells have been sunk in this small area, the extent of which, however, is very limited. Other wells have been bored around these, and they have proved unproductive.

There are two companies operating this gas field, besides municipalities like Dunnville and Leamington, which own wells and furnish gas to subscribers.

The two companies operating are the :—Natural Gas and Oil Co. of Ontario and the Essex Standard Co.

These two companies, however, have many interests in common, and an amalgamation is probable.

The Natural Gas and Oil Co. has forty-one wells bored, of which thirty are producers. Of these over fifteen have been drilled within the last three years. This company delivers gas in Windsor and Walkerville, through an 8 in. pipe, 33 miles long, laid down along the track of the Lake Erie and Detroit River Railway. It also delivers gas in Detroit, Michigan, situated on the Detroit River, opposite Windsor, by a 10 in. pipe line, 28 miles long, which runs along the road to Windsor, and crosses the Detroit River at Windsor.

These pipe-lines start from a reducing station near Kingsville, with which all the producing wells are connected. The pressure is here reduced from 350 lbs. (rock pressure) to 65 lbs. in the mains, during the summer, and 125 to 150 lbs. in winter, when the consumption being greater, a higher pressure has to be kept up. This pressure is further reduced to 10 lbs. in the street mains, and from these it is delivered to subscribers at 5 or 6 oz. All the gas is sold by meter.

The Essex Standard Co. owns several wells, situated to the south of the village of Ruthven, in the same territory as those owned by the Natural Gas and Oil Co., besides the small detached area mentioned above, in the township of Mersea.

This company delivers gas into Toledo, Ohio, by way of Detroit. They have a pipe-line from the reducing station near Ruthven, to Detroit, 8 in. in diameter, which crosses the river opposite Sandwich. From Detroit to Toledo the company takes advantage of an 8 in. pipe line, which used to supply Detroit from the Ohio fields.

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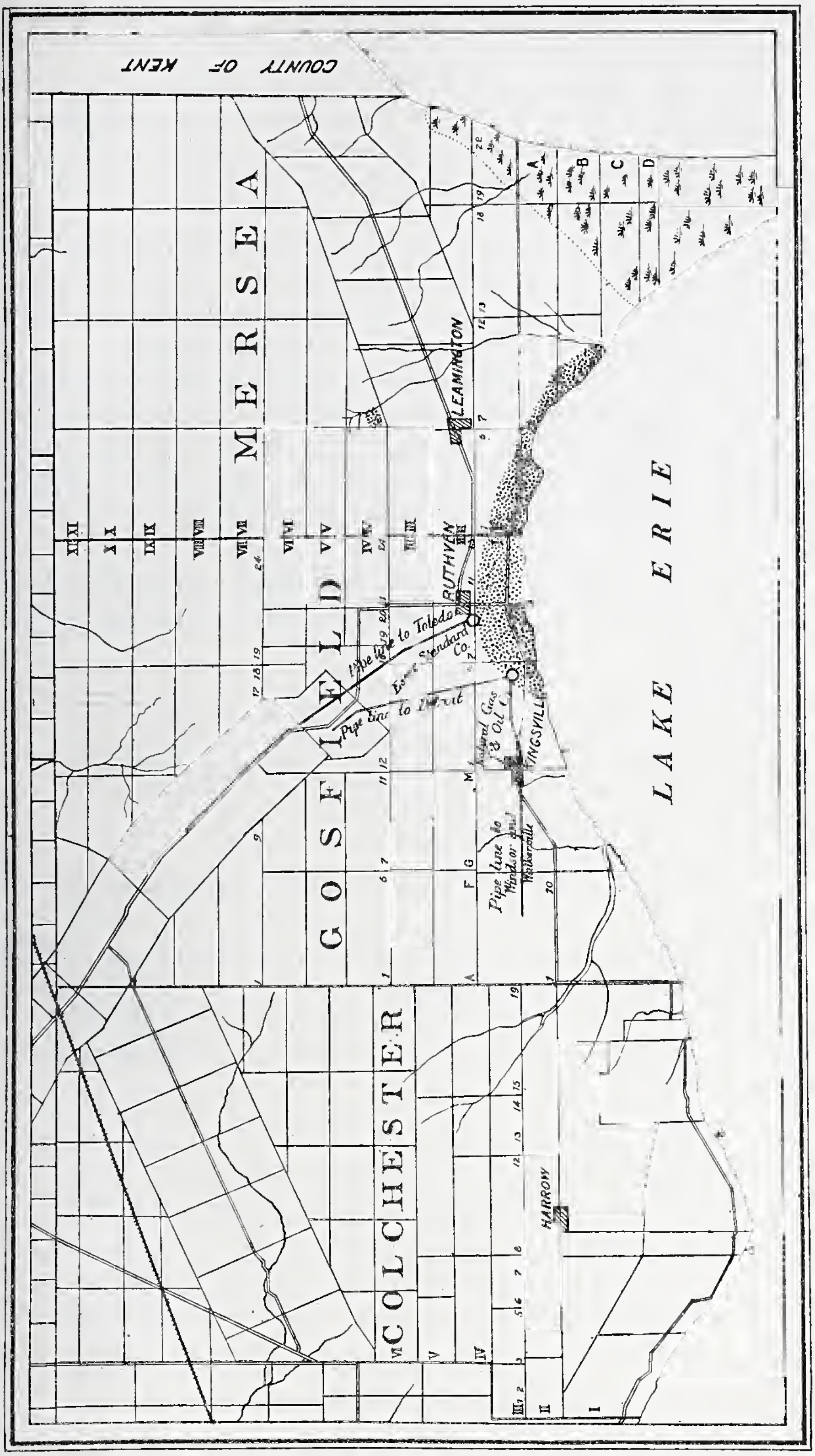


SKETCH MAP of GAS FIELD in ESSEX COUNTY, ONT.

Scale of statute miles

NATURAL GAS.

Welland County.—In this field there are several apparently detached areas from which gas is obtained the limits of which as derived from data so far available, have been sketched on the adjoining map.

The most important area is that which comprises the south-eastern part of Humberstone township and the south-western portion of Bertie township. The greater part of this territory is controlled by The Provincial Natural Gas Co.

Another important producing area is that situated to the west and north-west of Port Colborne, and which seems to extend to the canal bend, and take in an area north of Humberstone. Besides these there are other small patches which are shown in the sketch plan.

In this field the gas horizon is found to be a white friable sandstone, near the summit of the Medina formation. This horizon is struck at depths varying from 710 to 860 feet. The field has a decided dip to the south, the rise from the lake northwaıds being about 30 feet to the mile. The drift deposits vary from 6 to 40 feet or more in thickness.

The following log which is that of Well No. 1 of the Provincial Natural Gas Co., bored on lot 35, con, III, Bertie township, can be taken as a type for the wells of the field.

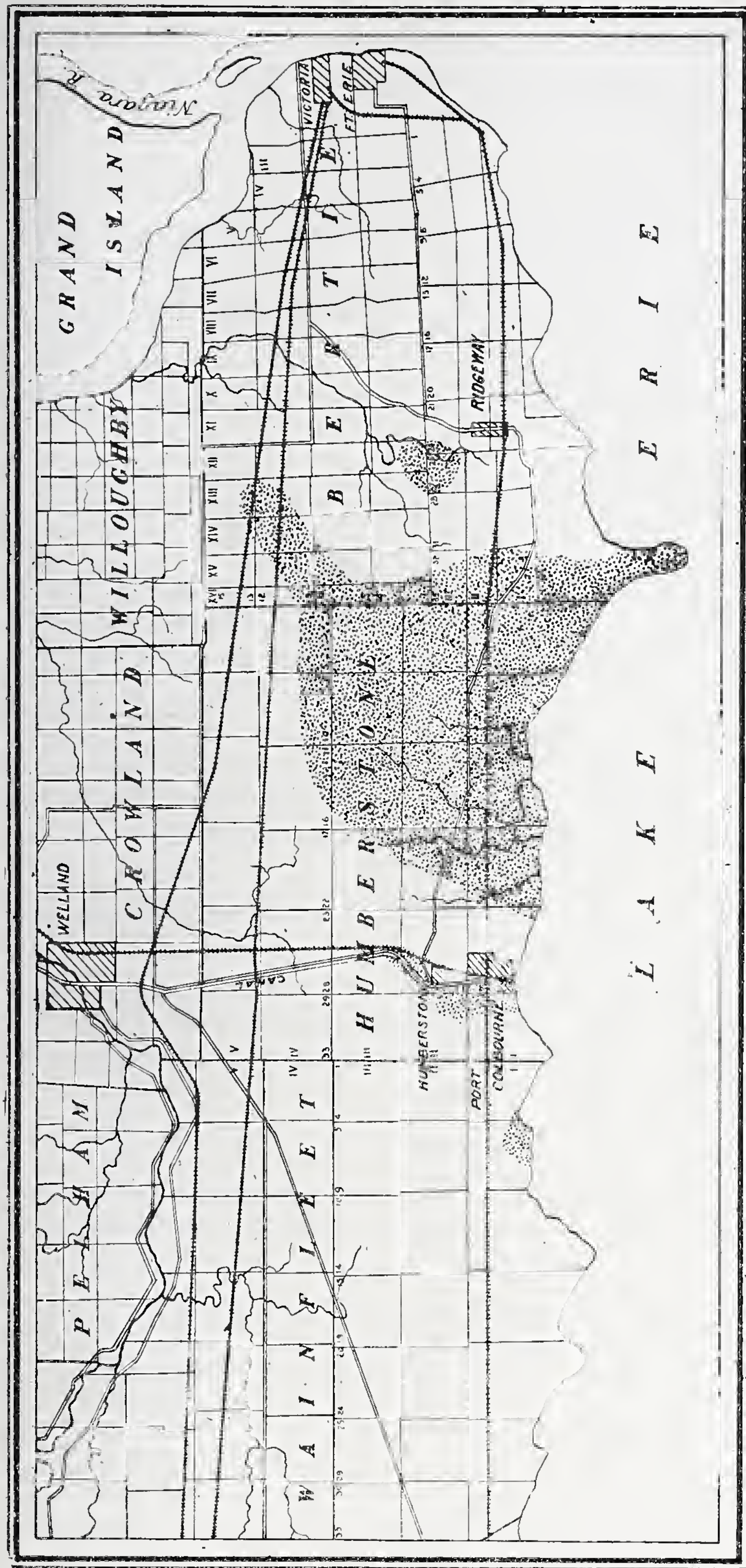
Surface....................	2	feet.	
Dark-gray lime............	23	"	Corniferous.
Dolomites, shales and gypsum..	390	"	Onondaga.
Grey dolomite	240	"	Guelph and Niagara.
Black shales................	50	"	Niagara.
White crystalline dolomite....	30	"	Clinton.
Sandstones and shales.......	111	"	Medina.

The gas is stuck in the white sandstone forming the last 16 feet of the section.

In the hope of striking gas or oil in the Trenton, the Provincial Gas Co. bored, in 1891, a well down to that formation, but without satisfactory economic results. The record of this well already published in a previous report of the Section of Mineral Statistics and Mines is as follows:

Surface deposits..........	47	feet	Drift.
Drab and grey dolomites and shales.................	293	"	Onondaga.
Grey and brown dolomite...	240	"	Guelph and Niagara.
Black shales	50	"	
White and grey dolomites..	30	"	Clinton.
Sandstones and shales......	1,000	"	Medina.
Limestone and shales......	865	"	Hudson River and Utica.
Limestone................	195	"	Trenton.
Total depth......	2,720	"	

NATURAL GAS.



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SKETCH MAP of GAS FIELD in WELLAND COUNTY, ONT.

Scale of statute miles

Natural Gas.

The exploitation of this field dates back to 1885, when gas was struck in Port Colborne on Charlotte St., through the operation of a local company. It was immediately put to use for lighting purposes. Port Colborne was therefore the first town in Canada to use natural gas.

Of the companies now operating in the Welland field, the Provincial Gas Co. is the largest. This company controls the greater part of the area comprising the south eastern part of Humberstone and the south-western part of Bertie townships. It began operations in 1890, with the object of supplying gas to Buffalo. The company has at present 140 wells sunk, of which seventy are producers, from which Fort Erie is supplied all the year round, and Buffalo during six months.

The average rock-pressure of this area at present is about 230 pounds. The depth at which gas is struck is on the average 830 to 840 feet.

The Mutual Natural Gas Co. and the Producers' Gas Co. control the area which lies immediately west of Port Colborne and extends north of Humberstone. These two companies are under the same management, and are practically amalgamated. The former supplies Port Colborne and vicinity, from the southern part of the field, where they have twenty wells, all connected with the main, although some of the wells are only very small producers. The latter supply Welland and vicinity from the area north of Humberstone, where they have five good wells.

The gas rock is struck at a depth of 700 to 750 feet, and the rock-pressure is about 200 pounds.

Besides the above, there are several minor companies delivering gas to subscribers in Port Colborne, Ridgeway and Sherkstone. A small area, lot 6, con. 1, Wainfleet township, is used to operate some limekilns at that place.

Quebec.

Champlain County.—In July, 1899, a find of natural gas in Champlain county, Champlain township, was reported. On investigation, however, it was found to be only a surface accumulation. This was struck on lot 503, while driving down a $1\frac{1}{2}$-inch pipe for water.

The layers passed through are as follows :—

Soil and sand	15 feet.
Clay	75 to 80 "
Fine sand with salt water	7 "
Boulder clay	15 to 20 inches.

The gas was struck in the layer of sand which underlies the clay, and is probably a pocket of carburetted hydrogen. It is inodorous and burns with a yellow flame. NATURAL. GAS.

NICKEL.

NICKEL.

The production of nickel in Canada in 1898, in so far as quantity is concerned, reached the highest figure that has been attained in the history of the industry, viz.: 5,517,690 lbs., or nearly 2,759 tons. Valued at 33 cents per pound, the average final market price of the metal, the total value of the production, was $1,820, 838. Compared with the previous year, the increase was, in quantity, 1,520,043 lbs., or 38 per cent, and in value, $421,662, or 30 per cent.

The total quantity of ore treated was 121,921 tons, consequently the nickel saved per ton averaged about 45·25 lbs., or 2·26 per cent.

The statistics of nickel production since 1889, are given in Table 1, below, the variations being shown graphically in Table E.

TABLE 1.

NICKEL.

ANNUAL PRODUCTION.

Production.

Calendar Year.	Pounds of nickel in matte.	Final Average Market price per lb. — New York.	Value.
1889	*830,477	60c.	$ 498,286
1890	1,435,742	65c.	933,232
1891	4,626,627	60c.	2,775,976
1892	2,413,717	58c.	1,399,956
1893	3,982,982	52c.	2,071,151
1894	4,907,430	38⅛c.	1,870,958
1895	3,888,525	35c.	1,360,984
1896	3,397,113	35c.	1,188,990
1897	3,997,647	35c.	1,399,176
1898	5,517,690	33c.	1,820,838

* Calculated from shipments made by rail.

The value of the exports of nickel according to the returns made to the Customs Department, are given in Table 2. Taking the quantities as given in Table 1, it will be seen that the value placed upon the nickel in the matte at the port of export has been about 18 cents per pound for the past two years.

NICKEL.
Produc-
tion.

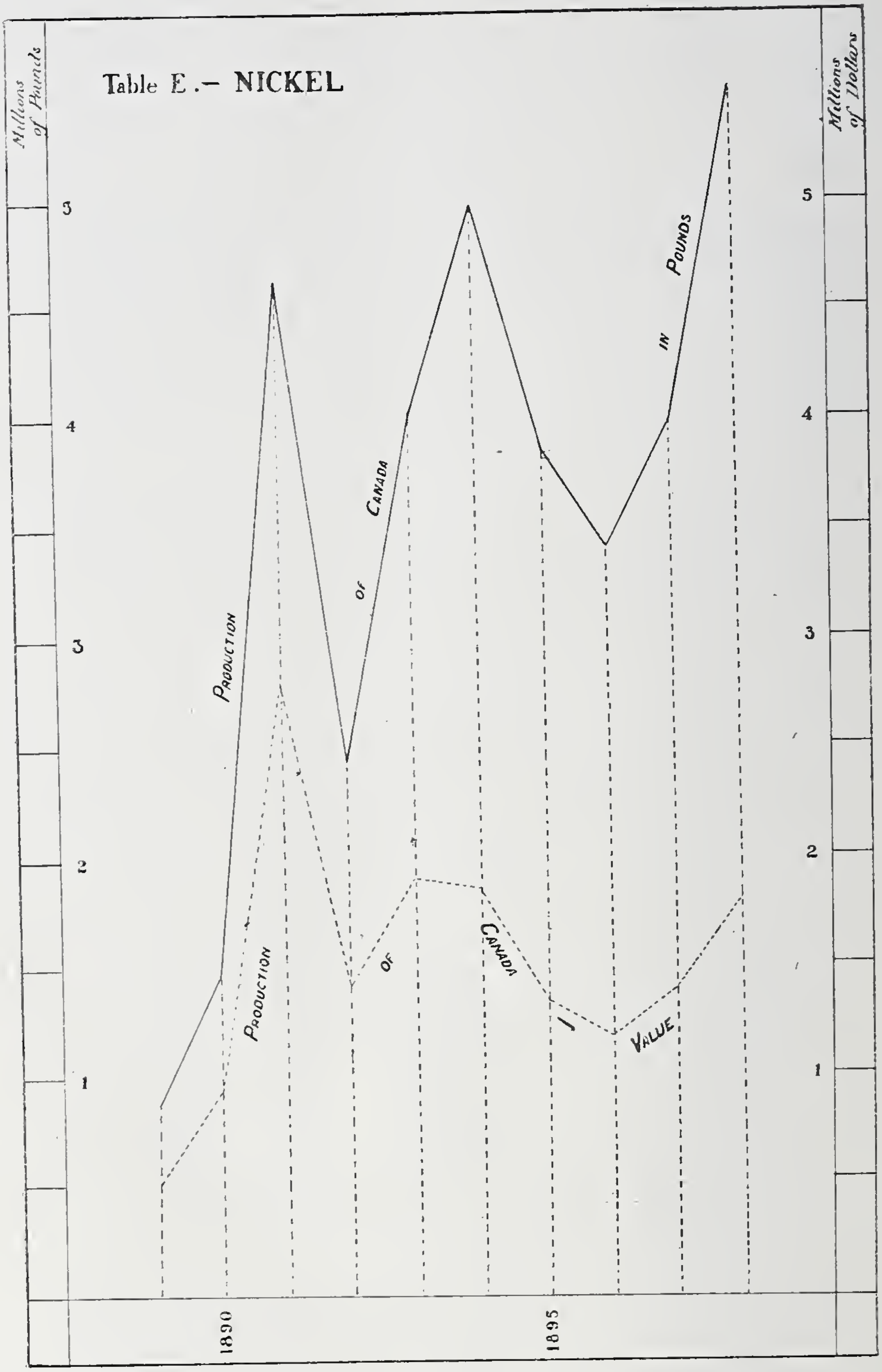


Table 2.

Nickel.

Exports.*

Nickel.

Exports.

Calendar Year.	Value.
1890	$ 89,568
1891	667,280
1892	293,149
1893	629,692
1894	559,356
1895	521,783
1896	658,213
1897	723,130
1898	1,019,363

* Practically all the nickel-bearing ore and matte produced in Canada is exported, the apparent discrepancy between Tables Nos. 1 and 2 being due to the different basis of valuation adopted in the two instances. Table 1 represents the total final values of the nickel produced in Canada, for the years represented. In Table 2 the worth of the product shipped is entered at its spot value to the operators, and depends upon the particular stage to which they happened to carry the process of extraction at the time *e.g.*, whether the shipments made are raw ore, low grade matte or high grade matte, etc.

Table 3.

Nickel.

Imports.

Imports.

Fiscal Year.		Duty.	Value.
1890			$ 3,154
1891			3,889
1892			3,208
1893			2,905
1894			3,528
1895			4,267
1896			4,787
1897			4,737
1898	Nickel anodes	10 p. c.	5,777
	Nickel. *	Free.	105
			$ 5,882

*Classified under the general heading of minerals in the Trade and Navigation Report.

There has been considerable activity in mining during the year. The Canadian Copper Co. has pushed operations, augmenting its plant by the addition of new smelters, and increasing the force employed. It

NICKEL.

is now capable of treating over 600 tons of ore per day. The mines of the H. H. Vivian Co. were closed down during the year, but boring operations were being proceeded with in order to test the various properties. A new nickel-copper property was opened up by Mr. T. M. Kirkwood, of Sudbury, on the south half of lot 8, con. 3, township of Garson. Two shafts were sunk on the ore-body, and several buildings, were erected. About 1,200 tons of ore was raised, said to run 4 per cent in nickel and about the same in copper. The property was, at the end of the year, taken over by R. G. Leckie, of Truro, Nova Scotia. The mines of the Trill Mining and Manufacturing Co. were not worked during that year, but the property was leased to Mr. Joseph Wharton, of Philadelphia, and a quantity of ore in stock was smelted and shipped to Camden, N. J.

PETROLEUM.

PETROLEUM.

The production of petroleum as given in the summary of the Mineral Production of Canada is calculated from the inspection returns of the Inland Revenue Department, and is obtained for the calendar year through the courtsey of that department. The figures as published for 1898 were, owing to the incompleteness of the returns, partially estimated. The revised figures were, however, obtained later and give the total quantity of refined Canadian oil inspected as 11,148,348 gallons. Taking the ratio of crude to refined oil as 100 to 42, this is equivalent to 26,543,685 gallons of crude oil or 758,391 barrels of 35 gallons.

The value of the oil at $1.40 per barrel, the average price for the year, was $1,061,747. The quantity of crude oil used in the refineries was 25,933,807 gallons, according to direct returns from the refiners.

There were four companies carrying on refining operations during the year :

The Imperial Oil Company (Limited), Petrolia.

The Bushnell Company (Limited), Sarnia and Petrolia.

The Petrolia Crude Oil and Tanking Co., Petrolia.

The Empire Oil Company, London.

The last two companies were in operation for six months only.

The total value of refined products, illuminating oils, etc., manufactured during the year was $1,825,265 an increase over the previous year of $152,836, but still less than the value attained in 1896.

Table 1 shows the production of illuminating oils and other products for the past three years, and Table 2, the consumption of crude oil and chemicals. Petroleum. Production.

TABLE 1.

PETROLEUM.

PRODUCTION OF CANADIAN OIL REFINERIES.

Products.	Calendar Years.					
	1896.		1897.		1898.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
		$		$		$
Illuminating oils. galls.	11,207,150	1,251,122	10,493,449	1,064,130	11,804,667	1,189,871
Benzine and naphtha .... "	719,453	70,733	747,163	71,978	1,229,407	120,651
Paraffine oils.... "	1,014,271	132,308	930,490	136,283	850,863	114,191
Gas and Fuel oils "	6.788,353	261,618	6,723,683	249,615	6,399,298	245,101
Lubricating oils and tar........ "	1,447.455	77,109	1,148,847	62,058	868,957	53,479
Paraffine wax.... lbs.	1,532,670	76,249	1,805,365	81,191	2,522,834	101,972
Axle grease...... "	318,928	7,774	227,079	7,174	....	....
Totals..........	....	1,876,913	....	1,672,429	....	1,825,265

TABLE 2.

PETROLEUM.

CONSUMPTION OF CRUDE OIL AND CHEMICALS.

Articles.	Calendar Years.			
	1895.	1896.	1897.	1898.
Crude petroleum .... galls.	24,954,855	25,881,095	25,488,230	25,933,807
Sulphuric acid .... lbs.	4,919,271	5,146,429	5,504,411	6,761,439
Soda.............. "	390,781	438,058	479,660	446,529
Litharge .... "	390,573	361,603	504,227	211,546
Sulphur............... "	78,597	80,612	65,349	35,014

The inspection of refined oils by the Inland Revenue Department affords a very convenient means of approximating the production of Canadian oil and of estimating the consumption both of Canadian and imported oils. Inspection of oils.

Table 4 gives the statistics of inspection of Canadian refined oils, and shews, besides the quantities of refined oils inspected, the crude equivalent in gallons, and also in barrels, and the total values.

Table 3 shows the details of inspection for the calendar year 1898 for both Canadian and imported oils.

PETROLEUM.

TABLE 3.

PETROLEUM.

Inspection of oils.

INSPECTION OF CANADIAN AND IMPORTED OILS, CALENDAR YEAR 1898.

Number of Packages.	Inspection Fee.	Approximate Number of Gallons per Package.	Total Gallons, Canadian.	Total Gallons, Imported.
	Cts.			
35	25	52	....	1,820
255,654	10	42	10,737,468	....
147,718	10	42	....	6,204,156
2	5	10	20	....
185	5	10	....	1,850
82,172	2½	5	410,860	....
125,047	2½	5	....	625,235
Total			11,148,348	6,833,061

TABLE 4.

PETROLEUM.

CANADIAN OILS AND NAPHTHA INSPECTED AND CORRESPONDING QUANTITIES OF CRUDE OIL.

Calendar Year.	Refined Oils Inspected.	Crude Equivalent Calculated.	Ratio of Crude to Refined.	Equivalent in Barrels of 35 Gallons	Average Price per Barrel of Crude.	Value of Crude Oil.
	Galls.	Galls.				
1881	6,457,270	12,914,540	100 : 50	368,987	....	....
1882	6,135,782	13,635,071	100 : 45	389,573	....	....
1883	7,447,648	16,550,328	100 : 45	472,866	....	....
1884	7,993,995	19,984,987	100 : 40	571,000	....	....
1885	8,225,882	20,564,705	100 : 40	587,563	....	....
1886	7,768,006	20,442,121	100 : 38	584,061	$0.90	$525,655
1887	9,492,588	24,980,494	100 : 38	713,728	0.78	556,708
1888	9,246,176	24,332,042	100 : 38	695,203	1.02⅔	713,695
1889	9,472,476	24,664,144	100 : 38	704,690	0.92¾	653,600
1890	10,174,894	26,776,037	100 : 38	795,030	1.18	902,734
1891	10,065,463	26,435,430	100 : 38	755,298	1.33¾	1,010,211
1892	10,370,707	27,291,334	100 : 38	779,753	1.26¼	984,438
1893	10,618,804	27,944,221	100 : 38	798,406	1.09½	874,255
1894	11,027,082	29,018,637	100 : 38	829,104	1.00¾	835,322
1895	10,674,232	25,414,838	100 : 42	726,138	1.49⅔	1,086,738
1896	10,684,284	25,438,771	100 : 42	726,822	1.59	1,155,647
1897	10,434,878	24,844,995	100 : 42	709,857	1.42½	1,011,546
1898	11,148,348	26,543,685	100 : 42	758,391	1.40	1,061,747

Table 5 shows the details of inspection of refined oils for the fiscal year, and Table 6, the number of gallons inspected both, Canadian and imported, and the percentage of each in the total for each year since 1881.

PETROLEUM.

Inspection of oils.

TABLE 5.

PETROLEUM.

INSPECTION OF CANADIAN AND IMPORTED OILS, FISCAL YEAR 1897-8.

Number of Packages.	Inspection Fee.	Approximate Number of Gallons per Package.	Total Gallons, Canadian.	Total Gallons, Imported.
	Cts.			
31	25	52	.. ..	1,612
248,210	10	42	10,424,820	....
149,420	10	42	....	6,275,640
*17	10	42	357	357
2	5	10	20	....
141	5	10	....	1,410
74,330	2½	5	371,650	....
120,343	2½	5	....	601,715
Total................			10,796,847	6,880,734

*Reported as mixed Canadian and Imported Oils and assumed to contain equal quantities of each.

TABLE 6.

PETROLEUM.

TOTAL AMOUNT OF OIL INSPECTED, CANADIAN AND IMPORTED.

Fiscal Year.	Canadian.	Imported.	Total.	Canadian.	Imported.
	Galls.	Galls.	Galls.	%	%
1881..........	6,406,783	476,784	6,883,567	93·1	6·9
1882.........	5,910,747	1,351,412	7,262,159	81·4	18·6
1883	6,970,550	1,190,828	8,161,378	85·4	14·6
1884..........	7,656,001	1,142,575	8,798,586	87·0	13·0
1885..........	7,661,617	1,278,115	8,939,732	85·7	14·3
1886	8,149,472	1,327,616	9,477,088	86·0	14·0
1887......	8,243,962	1,665,604	9,909,566	83·2	16·8
1888..........	9,545,895	1,821,342	11,367,237	84·0	16·0
1889..........	9,462,834	1,767,812	11,230,646	84·3	15·7
1890....	10,121,210	2,020,742	12,141,952	83·4	16·6
1891.....	10,270,107	2,022,002	12,292,109	83·6	16·4
1892..........	10,238,426	2,429,445	12,667,871	80·8	19·2
1893	10,683,806	2,641,690	13,325,496	80·2	19·8
1894.....	10,824,270	5,633,222	16,457,492	65·8	34·2
1895...	10,936,992	5,650,994	16,587,986	65·9	34·1
1896..........	10,533,951	5,807,991	16,341,942	64·5	35·5
1897..........	10,506,526	6,248,743	16,755,269	62·7	37·3
1898...	10,796,847	6,880,734	17,677,581	61·1	38·9

This table practically represents the consumption of refined petroleum in Canada. The increase has been fairly continuous, with a sudden rise in the imported oil between 1892 and 1894, due probably to the fact that in 1893 the inspection fees for imported petroleum were re-

PETROLEUM.

Inspection of oils.

duced from 25c., 10c., and 5c. to 10c , 5c. and 2½c., respectively. The percentage of imported oil of the total has steadily increased, reaching a maximum in 1898.

Similar statistics for the calendar years from 1892 to 1898 being available, the figures are given below in Table 7.

TABLE 7.

PETROLEUM.

TOTAL AMOUNT OF OIL INSPECTED, CANADIAN AND IMPORTED

Calendar Year.	Canadian.	Imported.	Total.	Canadian.	Imported.
	Galls.	Galls.	Galls.	%	%
1892.......	10,370,707	2,601,946	12,972,653	79·9	20·1
1893..........	10,618,804	4,520,392	15,139,196	70·1	29·9
1894..........	11,027,082	5,705,787	16,732,869	65·9	34·1
1895..........	10,674,232	5,677,381	16,351,613	65·3	34·7
1896..........	10,684,284	6,106,032	16,790,316	63·6	36·4
1897..........	10,434,878	6,628,361	17,063,239	61·2	38·8
1898..........	11,148,348	6,833,061	17,981,409	62·0	38·0

Statistics of the exports and imports of petroleum and its products, as obtained from the Trade and Navigation Reports, are given below in Tables 8, 9, 10, 11, 12.

TABLE 8.

PETROLEUM.

Exports.

EXPORTS OF CRUDE AND REFINED PETROLEUM.

Calendar Year.	Crude Oil.		Refined Oil.		Total.	
	Gallons.	Value.	Gallons.	Value.	Gallons.	Value.
1881	....	....	....	....	501	$ 99
1882	....	....	....	....	1,119	286
1883	....	....	....	....	13,283	710
1884	....	....	....	....	1,098,090	30,168
1885	....	....	....	....	337,967	10,562
1886	....	....	....	....	241,716	9,855
1887	....	....	....	....	473,559	13,831
1888	....	....	....	....	196,602	74,542
1889	....	....	....	....	235,855	10,777
1890	....	....	....	....	420,492	18,154
1891	446,770	$ 18,471	585	$104	447,355	18,575
1892	310,387	12,945	1,146	100	311,533	13,045
1893	107,719	3,696	2,196	394	109,915	4,090
1894	53,985	2,773	5,297	513	59,282	3,286
1895	22,831	1,044	10,237	2,023	33,068	3,067
1896	601	101	7,489	999	8,090	1,100
1897	....	....	342	49	342	49
1898	96	4	12,735	3,001	12,831	3,005

Petroleum.

Table 9.

Petroleum.

Imports of Petroleum and Products of.

Imports.

Fiscal Year.	Duty.	Gallons.	Value.
			$
1880		687,641	131,359
1881		1,437,475	262,168
1882		3,007,702	398,031
1883		3,086,316	358,546
1884		3,160,282	380,082
1885		3,767,441	415,195
1886		3,819,146	421,836
1887		4,290,003	467,003
1888		4,523,056	408,025
1889		4,650,274	484,462
1890		5,075,650	515,852
1891		5,071,386	498,330
1892		5,649,145	475,732
1893		6,002,141	446,389
1894		6,597,108	439,988
1895		7,577,674	525,372
1896		8,005,891	735,913
1897		8,415,302	697,169
1898 Oils: Mineral— (*a*) Coal and kerosene, distilled, purified or refined, naphtha and petroleum, N.E.S.	5c. p. gall.	8,011,240	$602,265
1898 (*b*) Products of petroleum	5c. "	147,188	15,983
1898 (*c*) Crude petroleum, fuel and gas oils (other than naptha, benzine or gasoline) when imported by manufacturers (other than oil refiners) for use in their own factories, for fuel purposes or for the manufacture of gas	2½c. "	533	58
1898 (*d*) Illuminating oils composed wholly or in part of the products of petroleum, coal, shale or lignite, costing more than 30 cents per gallon	25 p. c.	16,045	5,058
1898 (*e*) Lubricating oils composed wholly or in part of petroleum, costing less than 25 cents per gallon	5c. p. gall.	899,305	101,155
		9,074,311	724,519

PETROLEUM.

TABLE 10.*

PETROLEUM.

Imports.

IMPORTS OF CRUDE AND MANUFACTURED OILS, OTHER THAN ILLUMINATING.

Fiscal Year.	Gallons.
1881	960,691
1882	1,656,290
1883	1,895,488
1884	2,017,707
1885	2,489,326
1886	2,491,530
1887	2,624,399
1888	2,701,714
1889	2,882,462
1890	3,054,908
1891	3,049,384
1892	3,047,199
1893	1,481,749
1894	1,860,829
1895	1,106,907
1896	1,079,940
1897	800,411
1898	1,046,493

* This table is composed of items (*b*) and (*e*) of Table 9.

TABLE 11.

PETROLEUM.

Imports.

IMPORTS OF PARAFFINE WAX.

Fiscal Year.	Pounds.	Value.
1883	43,716	$ 5,166
1884	39,010	6,079
1885	59,967	8,123
1886	62,035	7,953
1887	61,132	6,796
1888	53,862	4,930
1889	63,229	5,250
1890	239,229	15,844
1891	753,854	50,275
1892	733,873	48,776
1893	452,916	38,935
1894	208,099	15,704
1895	163,817	11,579
1896	150,287	10,042
1897	138,703	7,945
1898 (Duty, 30 p. c.)	103,570	5,987

Petroleum.

Imports.

TABLE 12.

PETROLEUM.

IMPORTS OF PARAFFINE WAX CANDLES.

Fiscal Year.	Pounds.	Value.
1880	10,445	$2,269
1881	7,494	1,683
1882	5,818	1,428
1883	7,149	1,734
1884	8,755	2,229
1885	9,247	2,449
1886	12,242	2,587
1887	21,364	3,611
1888	22,054	2,829
1889	8,038	1,337
1890	7,233	1,186
1891	10,598	2,116
1892	9,259	1,952
1893	8,351	1,735
1894	10,818	1,685
1895	19,448	2,541
1896	25,787	4,072
1897	25,114	2,929
1898... Duty 25 p.c.	60,802	4,427

The average closing prices per barrel for crude oil on the Petrolia Oil Exchange are given in Table 13 below. There was no variation in the price in 1898, it having remained constant at $1.40 per barrel.

Prices.

TABLE 13.

PETROLEUM.

AVERAGE CLOSING PRICES FOR CRUDE OIL ON PETROLIA OIL EXCHANGE.

Months.	Calendar Years.						
	1892.	1893.	1894.	1895.	1896.	1897.	1898.
	$	$	$	$	$	$	$
January	1.29¼	1.18¼	1.01¼	1.16	1.72	1.50	1.40
February	1.29	1.18¾	1.01	1.19⅞	1.72	1.50	1.40
March	1.27¾	1.19	1.01	1.27	1.72	1.50	1.40
April	1.26	1.19	.99½	1.55¾	1.72	1.40	1.40
May	1.25¾	1.07	.92	1.67¼	1.70	1.40	1.40
June	1.27½	1.07	.92¾	1.52	1.50	1.40	1.40
July	1.26½	1.06	.94	1.54¼	1.50	1.40	1.40
August	1.26	1.05	.96	1.54	1.50	1.40	1.40
September	1.26¼	1.04½	.98	1.55½	1.50	1.40	1.40
October	1.26¾	1.04	1.06	1.59⅞	1.50	1.40	1.40
November	1.25	1.04	1.12¼	1.64½	1.50	1.40	1.40
December	1.18½	1.02	1.13½	1.72⅜	1.50	1.40	1.40
The Year	1 26¼	1.09½	1.00¾	1.49⅜	1.59	1.42½	1.40

Petroleum.

Mr. T. Denis furnishes the following remarks on the oil industry of Ontario, based on notes made by him in the field during 1898.

During the first part of 1898 oil refining was carried on by five different companies, operating six refineries. These six concerns were subsequently merged into two and finally into one.

The main feature of the oil industry in 1898 was the consolidation of the oil refining interests into one company, which took the name of "The Imperial Oil Company." This took place in the fall, the Imperial Oil Co. purchasing all the refining plants of Petrolia and Sarnia. The oil refining interests were formerly centered in Petrolia, where four large refining plants were situated. The industry has now its seat in Sarnia, where the company is operating the works of the Bushnell Oil Co. Sarnia, which lies about sixteen miles north-west of Petrolia, is claimed to be better situated to carry on the work ; being on the River St. Clair, at the head of Lake Huron, it affords much greater shipping facilities, and the Bushnell works are by far the best equipped to work economically. In consequence, the oil refining industry has practically been transferred from Petrolia to Sarnia. Some work which was begun in some of the Petrolia plants at the time of the purchase is being finished there, but it is intended as soon as this is done, to close down all the Petrolia works and to concentrate the industry in Sarnia.

Petrolia, however, is the natural centre of the crude oil production interests. The crude oil is gathered and tanked there from the different parts of the field and sent to Sarnia. Practically all the oil is shipped from Petrolia to Sarnia by a pipe line sixteen miles long and three inches in diameter, which is owned by the Imperial Oil Co.

The oil field of Petrolia contains about 7,000 wells, which are owned by some two hundred producers. The oil is pumped from an average depth of 465 feet, by engines, each of which works several wells, the power being transmitted hundreds of feet by a very ingenious contrivance of horizontal wooden rods which actuate the walking-beams of the pumps. The direction of the transmission of power is changed when needed by horizontal cranks. An engine of fifty H.P. can pump about 175 wells, each well producing on an average one-quarter of a barrel per twenty-four hours. The oil is gathered into a central tank which varies in size with the number of wells it receives. From these it is either transhipped by teams to one of the refinery's receiving stations, or else pumped to a central tank in Petrolia, by means of pipes laid by the Tanking Company through the oil-fields, and for the use of which pipes a small charge per barrel pumped is made. In this case each producer pumps separately from the tank on his

area, into the company's central tank, where the quantity is registered. From Petrolia the oil is sent to Sarnia by the Imperial Co.'s pipe line. PETROLEUM.

The Tanking Company has 62 miles of pipe for the purpose of gathering the crude oil from the producers' tanks into one central tank. Their line extends to Oil Springs and Oakdale. The charge of the Tanking Co. for the use of their pipe-line varies, according to the distance and the quantity sent from each area, from two cents to thirty-seven cents a barrel, this latter price being paid to send the oil from Oakdale which is about sixteen miles from Petrolia and a not very large receiving centre.

The tanks at Petrolia are dug in the blue Erie clay which is perfectly impermeable. They are lined with pine sticks for the purpose of preventing the sides from caving in. These reservoirs, of which there are fifty, have a storage capacity of 8,000 barrels each, or a total storage capacity of 400,000 barrels.

The Imperial Oil Co. has also several receiving stations in the Petrolia field, to which the producers take their crude oil.

The oil-producing areas of Ontario are confined to that part of the province which comprises Lambton county and the township of Zone, in Kent county. Within these limits there are six producing fields, differing much in size and importance. These separate oil pools are shown on the accompanying sketch map, which gives an idea of their relative sizes.

The list of the six fields with the approximate number of producing wells in each is given below :—

Petrolia field	about	7,000	wells.
Oil Springs	"	1,600	"
Bothwell	"	150	"
Euphemia	"	90	"
London Road	"	70	"
Dawn	"	60	"

The principal fields are at Petrolia and Oil Springs, their respective production approximating 45,000 and 12,000 barrels a month.

The oil is in every case found in the Corniferous limestone, and the different producing areas represent local dome-structures on the main anticlines, which afford good reservoirs for the accumulation of oil.

The oil obtained in Lambton county is dark brown in colour and has a gravity of 31 to 35 Beaumé. It differs very much from the oils of the United States, in that its sulphur-content is much higher. The United States crude oil does not usually contain more than five-tenths per cent of sulphur, whereas the Canadian oil runs as high as two and a

PETROLEUM.

half. This makes it much more difficult to refine, but by modern methods it is claimed that the complete elimination of the sulphur can be effected, and that the oil may be made equal in quality to the United States product.

Petrolia Field.—The producing area of the Petrolia centre is about two miles wide by twelve miles in length in a direction W. N. W. and E. S. E. from the town of Petrolia.

The oil-bearing strata are encountered at 460 to 480 feet from the surface, in the Corniferous limestone, which is found in every case to be overlain by the Hamilton limestones and shales, the latter affording the impermeable cover required for the accumulation of the oil. The average depth of the wells is 465 to 470 feet, and the strata traversed by the drill are very similar in various parts of the field. The following log of a well, sunk to a greater depth than usual for the purpose of testing the formation, may be taken as typical of the area :—

Surface	104 feet.	
Limestone	40 ″	Hamilton.
Shale	130 ″	
Limestone	15 ″	
Shale	43 ″	
Limestone	68 ″	
″ soft	40 ″	Corniferous.
″ grey	25 ″	
″ ″	135 ″	
″ hard, white	500 ″	With hard streaks of sandstone from 2 to 3 feet in thickness.
Gypsum	80 ″	Onondaga. Including the Oriskany, if present.
Salt and shale	105 ″	
Gypsum	80 ″	
Salt and shale	140 ″	
Total depth	1,505 feet.	

The crown of the dome which forms the Petrolia field seems to be located about the north-west corner of Petrolia city, at which place the surface of the Hamilton formation, overlying the petroliferous strata, has been eroded away, forming a plateau underlying the drift, of about two-thirds of a mile in diameter from the edges of which the rock dips on all sides. According to a Petrolia driller, a stratum which was struck at 340 feet beneath the surface on lot 13, con. XI., Enniskillen township, was encountered at 382 feet on lot, con. XII., which would give a fall of 42 feet in this distance of a little over four miles.

Oil Springs Field.—The Oil Springs field is about 800 acres in area and more circular in shape than the Petrolia field. The two are divided by a very distinct synclinal, revealed by borings, which of course proved unproductive of oil. Immediately beneath the drift are found the Portage shales which are underlain by the Hamilton forma-

tion. The oil-bearing stratum is struck at about 370 feet from the surface. This field was first opened in 1862, and has produced continuously ever since. The present monthly production of about 12,000 barrels, is all shipped to Petrolia by the Tanking Co's. pipe line. PETROLEUM.

Bothwell field.—Of the minor pools the Bothwell field, situated in Zone township, Kent county, has at present the greatest production. It runs parallel to the River Thames and is about three miles long by half a mile wide. The whole production amounting to some 4,000 barrels a month is shipped by car to Sarnia.

The field was opened and worked early in the 60's but subsequently abandoned after the discovery of the more prolific pools of Petrolia and Oil Springs. In 1896, however, a revival took place and there are now over 150 wells producing.

Lately a subsidiary pool was struck to the west of the main one, the position of which seems to indicate a continuation of the Bothwell field.

Euphemia Field. This is situated in Euphemia township. So far the proved producing area is but small, being confined to lots 26 and 27, con. IV. The production is about five hundred barrels monthly; this is partly teamed to Bothwell where it is shipped by rail to Sarnia, and partly teamed to the Tanking Co.'s station at Oakdale.

Dawn Field. In Dawn township a new producing area was opened in 1897. The limits of the pool are not yet very well defined, but the highest point of the dome seems to be on lot 17, con. XII, according to Dr. Fairbank of Petrolia, who has large interests in this new field, and who is developing it systematically. The production is about 600 barrels a month. This is sent to the Oakdale receiving station although a small part is teamed to Bothwell.

London Road Field. The latest addition to the producing territory is a small area north of the London Road, which was opened in 1898 by Mr. Fleming. The sinking of wells is being pushed very actively, but the discovery is as yet too recent to justify any prediction as to its importance.

Kent County.—In 1896 Mr. D. A. Gordon, of Wallaceburg, began sinking a well near the town, on lot 5, con. I of the Gore of Chatham, in the hope of finding oil, which he uses as fuel for the reverberatory furnaces of his glass factory. The well however proved dry. It was sunk down to 2,365 feet, at which depth is was abandoned. Samples of drillings, down to a depth of 2,100 feet were kindly sent to the Geo-

PETROLEUM. logical Survey department by Mr. Gordon. They were examined by Dr. H. M. Ami, who gave the following interpretation of the log:—

Sand, clays and boulder clays	140 feet.	
Limestones and shales, to	685 "	Chemung.
Shales and limestones, to	850 "	Hamilton.
Limestoue, light coloured, to.......	1,000 "	Coruiferous.
Fine grained dolomites and gypsifrous dolomites, to............ ...	1,700 "	Lower Helderberg Onondaga and Salina.
Dolomite..................	1,820 "	Guelph.
Limestone........	1,925 "	Niagara.
Shales, calcareous and arenaceous...	2,020 "	Clinton.
Sandstones, shales...........	2,085 "	Medina.

Mr. Gordon is now boring another well in Chatham township, about six miles E. S. E. of Wallaceburg. At this place, according to his observations, the upper 300 feet of the rock of the Wallaceburg section seem to have disappeared and the boring to have started 300 feet lower in the geological scale. The difference of level between the two wells is 4 to 5 feet. The Wallaceburg well being 10 to 12 feet above the level of Lake St. Clair and the second one 6 to 8 feet.

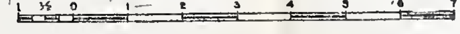
Essex County.—In this county, Mr. N. A. Coste, of Amherstburg, had a deep well sunk, which reached the Trenton at 2,150 feet, and was stopped at 2,450, or 300 feet into this formation. At this depth a light show of oil and gas was noticed. The well is situated in the township of Colchester South, on lot 64, con. 1, on the Woodbridge farm, $\frac{3}{4}$ of a mile from the lake and about 40 feet above its level. The log of this well was interpreted as follows by Mr. E. Coste :—

	Thickness.	Formation.
Soil..................	110 feet.	
Limestone and Dolomite, with Gypsum beds....	800 "	Onondaga.
Porous Dolomites.......	215 "	Guelph and Niagara.
Limestone.............	155 "	Clinton.
Shales and Limestone...	285 "	Medina.
" " ..	350 "	Hudson River.
Shales................	235 "	Utica.
Limestone.............	300 "	Trenton.
Total depth......	2,450 "	

On completion of this well, a second one was started, distant one mile N.E. from No. 1, and about $1\frac{1}{2}$ miles from the lake-shore. In July, 1899, the well was down 1,334 feet. In this well the first salt water was struck some 25 feet deeper than in No. 1, and from observations it would appear that the rocks have a decided dip to the north.

SKETCH MAP of OIL AREAS in LAMBTON COUNTY, ONT.

Scale of statute miles



QUEBEC.

PETROLEUM.

Gaspé Region.—In this region the Petroleum Oil Trust, according to the Provincial Mining Engineer, have been going on with development and preparatory work. Oil of good quality has been struck, but it remains yet to be proved whether it exists in paying quantities.

PHOSPHATE (*Apatite.*)

PHOSPHATE.

The statistics of phosphate production are given in Table 1 and the exports in Table 2, below. Only a small production is reported for 1898.

TABLE 1.

PHOSPHATE.

ANNUAL PRODUCTION.

Production.

Calendar Year.	Tons.	Average Value per ton.	Value.
1886	20,495	$14.85	$304,338
1887	23,690	13.50	319,815
1888	22,485	10.77	242,285
1889	30,988	10.21	316,662
1890	31,753	11.37	361,045
1891	23,588	10.24	241,603
1892	11,932	13.20	157,424
1893	8,198	8.65	70,942
1894	6,861	6.00	41,166
1895	1,822	5.25	9,565
1896	570	6.00	3,420
1897	908	4.39	3,984
1898	733	5.00	3,665

This industry has been practically dead for some years owing to the low prices for the mineral consequent on the competition of the cheaply mined phosphates from the Southern States and other sources. These practically debar the Canadian product from entering the European and United States markets at a figure profitable to the producer. In fact, Tennessee phosphate of high grade is now being used at Buckingham, Quebec, the former headquarters of the industry, in the manufacture of phosphorous by the electric method now carried on there. For this purpose and for the manufacture of superphosphates in Canada there is a small local demand.

Phosphate.

Exports.

Table 2.

Phosphate.

Exports.

Calendar Year.	Ontario.		Quebec.		Totals.	
	Tons.	*Value.	Tons.	*Value.	Tons.	*Value.
1878	824	$12,278	9,919	$195,831	10,743	$208,109
1879	1,842	20,565	6,604	101,470	8,446	122,035
1880	1,387	14,422	11,673	175,664	13,060	190,086
1881	2,471	36,117	9,497	182,339	11,968	218,456
1882	568	6,338	16,585	302,019	17,153	308,357
1883	50	500	19,666	427,168	19,716	427,668
1884	763	8,890	20,946	415,350	21,709	424,240
1885	434	5,962	28,535	490,331	28,969	496,293
1886	644	5,816	19,796	337,191	20,460	343,007
1887	705	8,277	22,447	424,940	23,152	433,217
1888	2,643	30,247	16,133	268,362	18,776	298,609
1889	3,547	38,833	26,440	355,935	29,987	394,768
1890	1,866	21,329	26,591	478,040	28,457	499,369
1891	1,551	16,646	15,720	368,015	17,271	384,661
1892	1,501	12,544	9,981	141,221	11,482	153,765
1893	1,990	11,550	5,748	56,402	7,738	67,952
1894	1,980	10,560	3,470	29,610	5,450	40,170
1895	....	....	250	2,500	250	2,500
1896	1	5	299	2,990	300	2,995
1897	70	450	165	400	235	850
1898	21	240	702	8,000	723	8,240

*These values do not compare with those in Table 1 above, the spot value being adopted for the production whilst the exports are valued upon quite a different basis.

Precious Metals.

PRECIOUS METALS.

The precious metals, gold and silver, are considered together, as in the past, for the reason that they often occur as constitutents of the same ores.

Gold.

Gold.

The main feature of the gold production for the year was the large output from the Yukon placers, causing an increase in the total gold production of the Dominion of no less than $7,748,404 or over 128 per cent. In 1897 the production was $6,027,016 and formed about 21 per cent of the total mineral production of the Dominion, while in 1898 the output reached $13,775,420 and constituted over 35 per cent of the total mineral value, making it considerably the most important mineral produced in the country in respect of value, coal

being the next in importance credited with 21 per cent of the total. In 1896 and 1897 gold was second in the list in relative importance. PRECIOUS METALS.

Of the various districts in which gold mining is carried on increases are shown in Quebec, Ontario, British Columbia and the Yukon district, while slight decreases have to be recorded for Nova Scotia and the Saskatchewan district of the North-west Territories. Gold.

In Nova Scotia, the production in 1898 was greater than in any preceding year with the exception of 1897, and less than 1897 by only $23,575 or 4 per cent.

Ontario shows the largest percentage increase over the previous year of any of the provinces, with the exception of the Yukon. The output in 1897 was $189,294 and in 1898 $265,889 or 40 per cent greater.

In British Columbia, the increase was only 7·8 per cent, the total production being $2,939,852, of which 77·4 per cent was obtained from vein mining and 22·6 per cent from placer mining. There was a larger increase in the gold obtained from placer mining than in that obtained from lode mining, the former being 25 per cent and the latter a little over 3 per cent.

The various provinces contributed to the Dominion total in approximately the following proportions : Yukon district, 72 per cent ; British Columbia, 21 per cent ; Nova Scotia nearly 4 per cent and Ontario nearly 2 per cent.

TABLE 1.

PRECIOUS METALS.

GOLD—ANNUAL PRODUCTION IN CANADA. Production.

Calendar Year.	*Ounces. Fine.	Value.
		$
1887	57,465	1,187,804
1888	53,150	1,098,610
1889	62,658	1,295,159
1890	55,625	1,149.776
1891	45,022	930,614
1892	43,909	907,601
1893	47,247	976,603
1894	54,605	1,128,688
1895	100,806	2,083,674
1896	133,274	2,754,774
1897	291,582	6,027,016
1898	666,445	13,775,420

* Calculated from the values at the rate of $20.67 per ounce.

Precious Metals.

Gold. Production.

TABLE 2.

PRECIOUS METALS.

GOLD: PRODUCTION BY PROVINCES AND DISTRICTS, CALENDAR YEAR 1898.

Provinces.		*Ounces. Fine.	Value.
Nova Scotia	(b)	26,057	$ 538,590
Quebec	(a)	294	6,089
Ontario	(b)	12,864	265,889
North-west Territories—			
Saskatchewan (estimated)	(a)	1,209	25,000
Yukon District (estimated)	(a)	483,793	10,000,000
British Columbia	(c)	142,228	2,939,852
Total		666,445	$13,775,420

*Calculated from the values at the rate of $20 67 per ounce.
(a) Placer gold.
(b) Gold produced in treating free milling ores.
(c) As follows: Gold from placer mining ....$ 664,891
" " vein " 2,274,961

$ 2,939,852

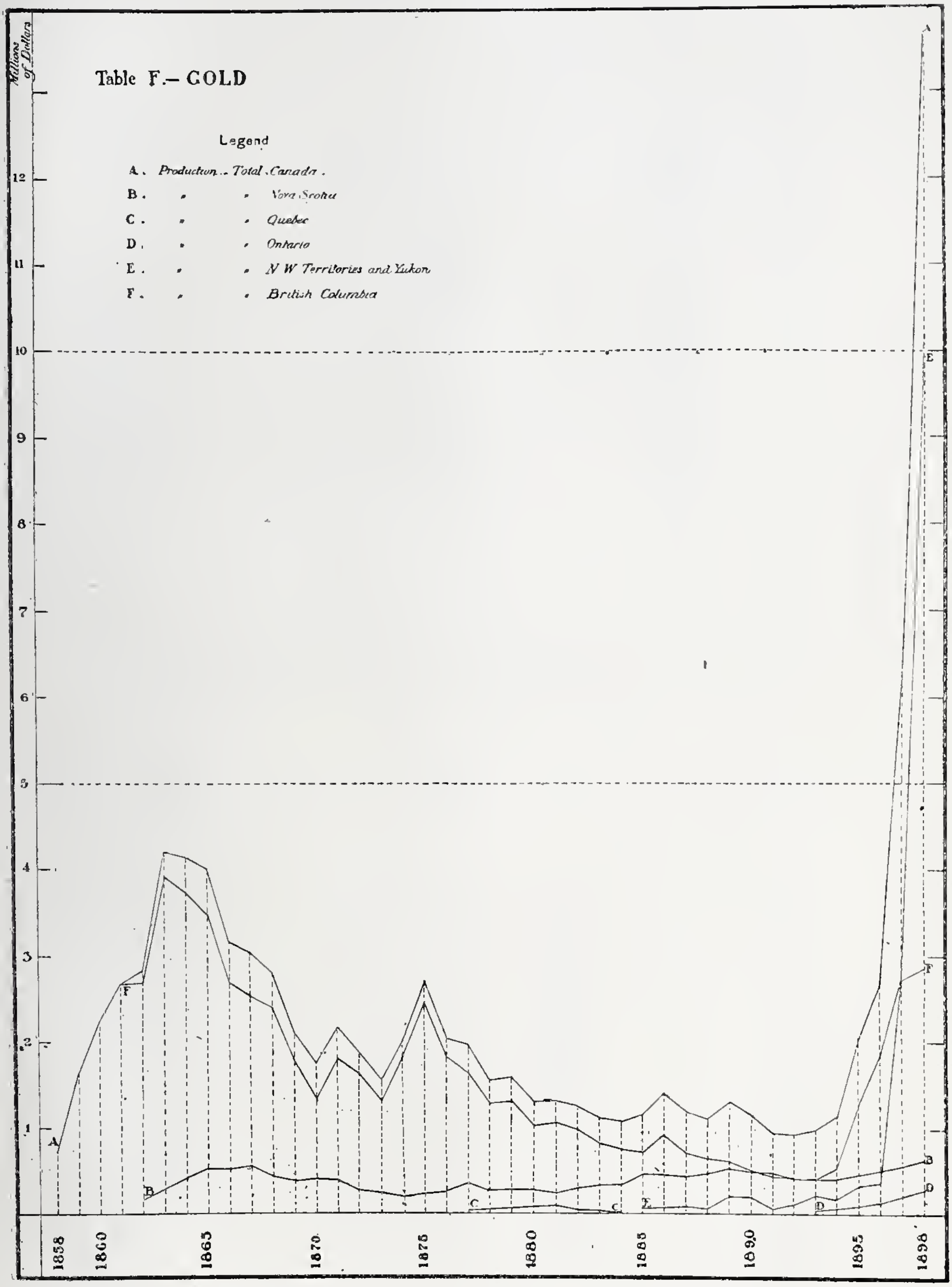
Nova Scotia.

NOVA SCOTIA.

The statistics of gold production in Nova Scotia are given in Tables 3, 4, 5 and 6. Table 3, shows the annual gold output, Table 4 the tons of quartz crushed and the average yield per ton. In table 5 the total production of each district from 1862 to the end of 1898 is exhibited as well as the average yield per ton, and Table 6 shows the amount of ore crushed and the yield per district for 1898.

Although the gold recovered in 1898 was less than that in 1897 by 4 per cent, the quantity of quartz crushed was greater, the increase being 9,582 tons or 13 per cent. The average gold-content per ton of the ore crushed in 1898 was thus 6 dwts. 16 grs. or $6.50, while in 1897 it was 7 dwts. 21 grs. or $7.68.

The production of about 17 different districts is shown, there being 54 mines and 43 mills represented. Three of the largest districts viz., Brookfield, Sherbrooke and Stormont, produced over 58 per cent of the total, while seven others, Leipsigate, Malaga Barrens, Montague, Oldham, Tangier and Uniacke produced from 1,000 ozs. to 2,000 ozs. each, accounting for nearly 28 per cent more. The average returns per ton of ore for the different districts varies from 2 dwts. 15 grs. or $2.56 for Caribou to 2 oz. 7 dwts. 2 grs. or or $45.90 for Gold River.


Millions of Dollars
Table F.— GOLD
Legend
A. Production – Total Canada.
B. " " Nova Scotia
C. " " Quebec
D. " " Ontario
E. " " N W Territories and Yukon
F. " " British Columbia
12
11
10
9
8
7
6
5
4
3
2
1
1858
1860
1865
1870
1875
1880
1885
1890
1895
1898

Precious Metals.
Gold.
Nova Scotia.

TABLE 3.

PRECIOUS METALS.

GOLD :—NOVA SCOTIA—ANNUAL PRODUCTION.

Calendar Year.	Value.	Calendar Year.	Value.
1862	$141,871	1881	$209,755
1863	272,448	1882	275,090
1864	390,349	1883	301,207
1865	496,357	1884	313,554
1866	491,491	1885	432,971
1867	532,563	1886	455,564
1868	400,555	1887	413,631
1869	348,427	1888	436,939
1870	387,392	1889	510,029
1871	374,972	1890	474,990
1872	255,349	1891	451,503
1873	231,122	1892	389,965
1874	178,244	1893	381,095
1875	218,629	1894	389,338
1876	233,585	1895	453,119
1877	329,205	1896	493,568
1878	245,253	1897	562,165
1879	268,328	1898	538,590
1880	257,823		

TABLE 4.

PRECIOUS METALS.

GOLD :—NOVA SCOTIA, ORE TREATED AND YIELD OF GOLD PER TON.

Calendar Year.	Tons Treated.	Yield of Gold per Ton.	Calendar Year.	Tons Treated.	Yield of Gold per Ton.
1862	6,473	$21·91	1881	16,556	$12·66
1863	17,000	16·02	1882	21,081	13·04
1864	21,431	18·21	1883	25,954	11·60
1865	24,421	20·32	1884	25,186	12·44
1866	32,157	15·28	1885	28,890	14·98
1867	31,384	16·96	1886	29,010	15·70
1868	32,259	12·41	1887	32,280	12·81
1869	35,144	19·91	1888	36,178	12·08
1870	30,824	12·56	1889	39,160	13·02
1871	30,787	12·17	1890	42,749	11·11
1872	17,089	14·94	1891	36,351	12·42
1873	17,708	13·05	1892	32,552	11 98
1874	13,844	12·87	1893	42,354	8·99
1875	14,810	14·76	1894	55,357	7·04
1876	15,490	15·08	1895	60,600	7·47
1877	17,369	18·95	1896	69,169	7·13
1878	17,989	13·63	1897	73,192	7·68
1879	15,936	16·83	1898	82,774	6·50
1880	13,997	18 42			

Precious Metals.
Gold.
Nova Scotia.

Table 5.

Precious Metals.

Gold :—Nova Scotia. Production of the Different Districts from 1862 to 1898 inclusive.

Districts.	Tons of Ore Crushed.	Total Yield.				Average Yield per Ton of 2,000 lbs.
		Oz.	Dwts.	Grs.	Value at $19.50 per Oz.	
					$	$ cts.
Brookfield	33,838	18,884	12	4	368,250	10 88
Caribou	107,460	40,234	10	5	784,573	7 30
Central Rawdon	13,340	10,121	11	21	197,371	14 80
Fifteen-Mile Stream	40,280	18,132	13	5	353,587	8 78
Killag	1,C27	1,527	16	12	29,793	29 00
Lake Catcha	13,237	11,591	7	7	226,032	17 07
Malaga	23,823	16,606	4	21	323,821	13 59
Montague	23,451	38,358	11	10	747,992	31 90
Oldham	45,551	50,405	4	20	982,902	21 58
Renfrew	48,576	34,022	1	2	663,430	13 66
Salmon River	84,028	31,966	18	19	623,355	7 42
Sherbrooke	211,714	136,146	9	10	2,654,856	12 54
Stormont	149,605	57,908	14	23	1,129,220	7 55
Tangier	35,743	21,395	2	2	417,205	11 67
Uniacke	55,075	38,190	18	8	744,723	13 52
Waverly	119,954	60,939	..	19	1,188,311	9 91
Wine Harbour	44,837	30,013	11	6	585,265	13 05
Whiteburn	7,368	10,213	18	20	199,172	27 03
Unproclaimed	64,046	47,550	8	1	927,233	14 47
Totals	1,122,953	674,209	15	23	13,147,091	11 71

PRECIOUS METALS.

Gold.

Nova Scotia.

TABLE 6.

PRECIOUS METALS.

GOLD :—NOVA SCOTIA DISTRICT DETAILS—CALENDAR YEAR 1898.

Districts.	Mines.	Mills.	Tons of Ore Crushed.	Total Yield of Gold.			Average Yield of Gold per Ton.		
				Oz.	Dwt.	Grs.	Oz.	Dwt.	Grs.
Brookfield	3	1	8,196	2,659	..	..	..	6	11
Caribou	6	5	5,724	756	9	6	..	2	15
Fifteen-Mile Stream	2	1	3.875	648	12	..	..	3	8
Gold River	3	2	307	723	2	4	2	7	2
Kemptville	1	1	158	65	19	..	..	8	8
Killag	2	1	265	337	11	..	1	5	11
Lake Catcha	2	2	696	480	9	11	..	13	19
Leipsigate	2	2	3,772	1,478	6	..	..	7	20
Malaga Barrens	1	1	745	1,143	..	..	1	10	16
Montague	3	2	1,925	1,027	..	20	..	10	16
Oldham	1	1	589	1,085	..	8	1	16	20
Sherbrooke	4	4	17,893	5,575	14	16	..	6	5
Stormont	8	8	33,287	7,870	14	2	..	4	17
Tangier	2	1	960	1,192	19	..	1	4	20
Uniacke	4	3	1,972	1,746	10	18	..	17	17
Waverly	1	1	582	377	2	16	..	12	23
Wine Harbour	2	2	891	207	8	17	..	4	15
Other districts	7	5	937	245	13	2	.	5	5
Totals and averages	54	43	82,774	27,620	13	..	..	6	16

Quebec.

QUEBEC.

Gold mining in Quebec which has been carried on in the alluviums and auriferous gravels of the river-valleys in a restricted area of the Eastern Townships has been of a very uncertain and variable nature in the character and extent of its returns, as shown by the figures in the accompanying Table 7.

TABLE 7.

PRECIOUS METALS.

GOLD :—QUEBEC, ANNUAL PRODUCTION.

Calendar Year.	Value.	Calendar Year.	Value.
1877	$12,057	1888	$3,740
1878	17,937	1889	1,207
1879	23,972	1890	1,350
1880	33,174	1891	1,800
1881	56,661	1892	12.987
1882	17,093	1893	15,696
1883	17,787	1894	29,196
1884	8,720	1895	1,281
1885	2,120	1896	3,000
1886	3,981	1897	900
1887	1,604	1898	6,089

The chief work done in 1898 was in the Chaudière district on the Gilbert River, by two companies, The Gilbert Beauce Gold Mining Company and the Compagnie Franco-Canadienne. The first named company, in the summer of 1897, obtained the right to work lots 15, 16 and 17 De Lery on the Gilbert River and began by opening a trench and other work to drain the property. It was on these lots that several well known nuggets had been found, and the ground had been proved the richest in gold in the district. It was the intention of the company to get at the old river gravels which were believed to contain gold in paying quantities. Flumes were built in the spring of 1898 to divert the course of the river, and appear to have given satisfaction. Owing to protracted legal difficulties, and subsequently to lack of means, Mr. Lockwood the previous operator on this river, had never been able to inaugurate a proper system of drainage to deal with the water encountered. The system then proposed by him has now been carried out, however, and is said to be working well. The average yield of the gravel is said to be from 25 to 50 cents per cubic foot. PRECIOUS METALS. Gold. Quebec.

The Compagnie Franco-Canadienne began work in July, 1898, on lot 14 De Lery. This company commenced operations on an old shaft of the American Gold Company, but after some work, quicksand was struck, and, owing to the sinking of the surface, machinery and buildings had to be removed and work was commenced on a new shaft. This shaft is 40 feet deep, and passes through 2 feet of surface soil, 32 feet of blue clay, then 6 feet of gravel overlaid by a thin layer of cemented gravel. A thickness of four feet of this gravel is auriferous. Drifts were run to the north-west and south-east, but the latter, in the direction of the river, was abandoned at the end of 25 feet and the work was carried on in the other direction, parallel to the line between lots 13 and 14, where the auriferous gravel continues in a very regular manner over a width of from 80 to 300 feet. Two feet of gravel and 18 inches of bed-rock were washed, the remaining 3 feet, containing about 20 cents to the cubic foot, is not considered rich enough to wash under present conditions, that is with the rocker. A force of 25 men were employed night and day. Two pumps and a steam hoist were in use and a special installation for washing consisting of a large box 12 feet by 4 with a perforated board at the bottom, serving instead of riffles, into which the water falls from a height of about 15 feet. The gravel from the mine is thrown into this box where it is partly disintegrated and then carried off into the sluice a good portion of the gold remaining in the box.*

*Report on the Mines of the Province of Quebec, 1898, by J. Obalski, Provincial Mining Engineer.

Precious Metals.
Gold.
Quebec.

Mr. A. Coupal, worked for about seven months on the Ruisseau des Meules and obtained some nuggets of good size. Owing to difficulties with the grantee of the mines, however, the works were finally abandoned. Considerable prospecting was done in Dudswell and Ditton but with small result in so far as returns are concerned.

Ontario.

Ontario

In Ontario the number of mines and prospects which turned out bullion was somewhat greater than in the previous year, and the production of the larger mines considerably increased. According to the returns received, the total quantity of ore mined was 56,433 tons from which there was obtained 16,214 crude ounces of bullion valued at $265,889 or an average value per ounce of $16.40. The value per ton of the ore treated varied from $3.24 to $17.52 and averaged for the whole output $4.71. In 1897, the average value per ton of ore was $6.74, the decrease in 1898 being a little over $2 per ton or nearly 30 per cent.

Table 8.

Precious Metals.

Gold—Ontario—Annual Production.

Calendar Year.	*Ounces (fine).	Value.
		$
1887	327	6,760
1888	....	....
1889	....	....
1890	....	....
1891	97	2,000
1892	344	7,118
1893	708	14,637
1894	1,917	39,624
1895	3,015	62,320
1896	5,563	115,000
1897	9,158	189,294
1898	12,864	265,889

*Calculated from the value at $20.67 per ounce.

Over 79 per cent of the total production was obtained from four of the largest properties, the Regina, Sultana and Mikado in the Lake of the Woods district, western Ontario, and the Belmont in the Hastings district, eastern Ontario.

The production of the Deloro mine, Hastings district, owned by the Canadian Gold Fields Limited, was comparatively small owing to the destruction of the mill by fire in the early part of the year. The mine

is equipped with a double hoisting engine, a 20-drill air-compressor and a large pumping plant. All appliances are of modern construction and have been but recently installed. A new 10-stamp mill has been built to take the place of the one destroyed and a bromo-cyanide plant has been erected to treat the tailings. Up to the present the company has been working for gold only, but arsenic will be produced in the immediate future.

PRECIOUS METALS. Gold. Ontario.

Active work is being continued on the Belmont mine which is being opened up by the Cordova Exploration Company Limited. A considerable amount of ore was treated during the year and a large amount of exploration work, drifting extension of levels etc., accomplished. 'The plant consists of a grizzley, Blake crusher, 9 inches by 15 inches, 10 stamps of 850 pounds each, one Frue vanner, six-foot belt, corrugated, one Frue vanner, four-foot belt, plain, and one gyrating vanner, six-foot belt, and three pointed settling boxes in a series for all tailings. Power is derived from a 40 h. p. engine and boiler in adjacent room.' *

At the Regina mine, the mill and mine were idle for four months while a new plant was being installed. The Sultana and Mikado continued operations on an extended scale and with increased output. Among the other producing mines those of chief importance were the Sawbill, Hammond Reef, Foley, Olive, and Golden Star.

NORTH-WEST TERRITORIES

North-west Territories.

The statistics of production of gold in the North west Territories are set forth on Table 9, the gold obtained from the Saskatchewan River district being given separately from that of the Yukon district. The production is all from placer workings; quartz mining not yet having been attempted in the Yukon, and when several thousand men are independently engaged in the production of the precious metal, the difficulty of obtaining accurate statistics of the total production will be readily appreciated. The figures given in the table though approximations, are believed to represent fairly well the actual quantities obtained.

* Report of the Bureau of Mines, Ontario, Vol. VIII p. 41.

Precious Metals.

Gold.

North-west Territories.

TABLE 9.

PRECIOUS METALS.

GOLD :—NORTH-WEST TERRITORIES—PRODUCTION.

Calendar Year.	Yukon District.		Saskatchewan River.	
	*Ounces (fine).	Value.	*Ounces (fine).	Value.
		$		$
1885, 1886	4,838	100,000	....	....
1887	3,387	70,000	102	2,100
1888	1,935	40,000	58	1,200
1889	8,466	175,000	968	20,000
1890	8,466	175,000	194	4,000
1891	1,935	40,000	266	5,500
1892	4,233	87,500	508	10,506
1893	8,515	176,000	466	9,640
1894	6,047	125,000	725	15,000
1895	12,095	250,000	2,419	50,000
1896	14,514	300,000	2,661	55,000
1897	120,948	2,500,000	2,419	50,000
1898	483,793	10,000,000	1,209	25,000
Total	679,172	14,038,500	11,995	247,946

*Calculated from the value at $20.67 per ounce.

Some notes by Dr. Dawson concerning gold on the Saskatchewan will be found in the Summary Report of the Geological Survey for 1898, pp. 11-20. The condition of the industry is there well described and need not be enlarged upon here.

Placer gold mining has been carried on in the Yukon Territory since 1881. The industry began with river-bar mining on the Lewes, Salmon, Stewart and other rivers. In 1886 coarse gold was discovered on Forty-mile River, and, subsequently, a number of the tributaries of this river, and also of Sixty-mile River, a neighbouring stream, were found to be auriferous. In 1896 the Klondike discovery was announced, and the centre of the industry was moved there. This new and very rich field has an area of about 800 square miles. The principal auriferous streams are Bonanaza, with its tributary Eldorado Creek, Bear Creek and Hunker Creek flowing into the Klondike; Quartz Creek and Dominion Creek, with its two tributaries Gold Run and Sulphur creeks, flowing into Indian River. The total length of the paying portions (at present) of the productive creeks aggregates about fifty miles. The richest parts of the valleys yield at the rate of about $2,000 per running foot, with a pay-steak 150 to 300 feet in width. The creek-gravels have a thickness, as a rule, of from six to ten feet, and

Precious Metals.

Gold.

North-west Territories.

are overlain by a bed of black 'muck' usually from ten to fifteen feet in thickness. The lower three or four feet of the gravels, with about two feet of the underlying broken and decomposed bed-rock, hold the greater part of the gold. Besides the stream-gravels, auriferous gravel terraces occur on the sides of most of the valleys, and Bonanza, Eldorado, Hunker and Quartz creeks are also bordered in places by wide rock-cut flats at elevations ranging from 100 to 300 feet above the present valley-bottoms, on which heavy deposits of gravel have been accumulated. These gravels represent the wash of older valleys that followed approximately the direction of the present ones, and have a thickness in places of over 100 feet. They are everywhere more or less gold-bearing, and in places, especially towards the base of the formation, are extremely rich. Klondike gold occurs, as a rule, in coarse grains, usually showing some degree of angularity, and is often quite rough and unworn. Small nuggets are plentiful in places, and larger ones up to about $1,000 in value are occasionally found. The grade of the gold varies in the different creeks from about $14.50 to $17.50 per ounce.

British Columbia.

British Columbia.

The gold production in British Columbia in 1898 did not maintain the high rate of increase shown during the two or three previous years. The production in 1898 was $2,939,852, the increase over the production of 1897 being only 7·8 per cent as compared with an increase of 52·4 per cent in the production of 1897 over 1896, an increase of 41·1 per cent in the production of 1896 over 1895.

Precious Metals.
Gold.
British Columbia.

The statistics of production for the province are shown in Table 10.

Table 10.

Precious Metals.

Gold—British Columbia—Annual Production.

Calendar Year.	Value.	Calendar Year.	Value.
	$		$
1858	705,000	1879	1,290,058
1859	1,615,072	1880	1,013,827
1860	2,228,543	1881	1,046,737
1861	2,666,118	1882	954,085
1862	2,656,903	1883	794,252
1863	3,913,563	1884	736,165
1864	3,735,850	1885	713,738
1865	3,491,205	1886	903,651
1866	2,662,106	1887	693,709
1867	2,480,868	1888	616,731
1868	2,372,972	1889	588,923
1869	1,774,978	1890	494,436
1870	1,336,956	1891	429,811
1871	1,799,440	1892	399,525
1872	1,610,972	1893	379,535
1873	1,305,749	1894	530,530
1874	1,844,618	1895	1,266,954
1875	2,474,904	1896	1,788,206
1876	1,786,648	1897	2,724,657
1877	1,608,182	1898	2,939,852
1878	1,275,204		

Table 11 gives details as to the number of men employed in placer mining and the average earnings per man, but is incomplete for the past three years, the data available being insufficient.

PRECIOUS METALS.
Gold.
British Columbia.

TABLE 11.

PRECIOUS METALS.

GOLD—BRITISH COLUMBIA—ANNUAL EARNINGS PER MAN, ETC.

Calendar Year.	Number of Men Employed.	Average Annual Earnings per Man.	Calendar Year.	Number of Men Employed.	Average Annual Earnings per Man.
1858	3,000	235	1877	1,960	820
1859	4,000	403	1878	1,883	677
1860	4,400	506	1879	2,124	607
1861	4,200	634	1880	1,955	518
1862	4,100	648	1881	1,898	551
1863	4,400	889	1882	1,738	548
1864	4,400	849	1883	1,965	404
1865	4,294	813	1884	1,858	396
1866	2,982	893	1885	2,902	246
1867	3,044	814	1886	3,147	287
1868	2,390	992	1887	2,342	296
1869	2,369	749	1888	2,007	307
1870	2,348	569	1889	1,929	330
1871	2,450	734	1890	1,342	423
1872	2,400	671	1891	1,199	358
1873	2,300	567	1892	1,340	298
1874	2,868	643	1893	1,247	304
1875	2,024	1,222	1894	1,610	283
1876	2,282	783	1895	2,030	313

Precious Metals.
Gold.
British Columbia.

Table 12 is taken from the annual report of the Minister of Mines for the province and shows the production by districts for 1898.

Table 12.

Precious Metals.

Gold—British Columbia, Production by Districts, Calendar Year, 1898.

District.	Division.	Placer.		Quartz.	
		Ounces.	Value.	Ounces.	Value.
			$		$
Cariboo	Barkerville........	4,725	94,500	....	....
	Lightning Creek...	1,850	37,000	....	....
	Quesnel Mouth....	1,400	28,000	....	....
	Keithley Creek....	10,743	214,860	....	....
	Omineca..........	750	15,000	....	....
Cassiar..........	Atlin Lake........	3,750	75,000	....	....
	All other.........	1,615	32,300	....	......
Kootenay East ..	....	850	17,000	....	....
Kootenay West..	Nelson...........	....	....	3,823	76,459
	Slocan	....	....	60	1,194
	Trail Creek	....	....	87,343	1,746,861
	Other Places	552	11,040	346	6,923
Lillooet	....	2,130	42,614	260	5,200
Yale	Osoyoos..........	382	7,632	17,824	356,480
	Similkameen	378	7,560	....	....
	Yale............	3,042	60,840	....	....
Other Districts ..	....	....	....	405	8,100
		32,167	643,346	110,061	2,201,217

Placer Mining.—The gold obtained from placer mining forms over 22 per cent of the production of the province and the increase over the amount produced from placer mining in 1897 was 25 per cent. The increases are distributed over all the districts with the exception of Yale, in which the divisions of Osoyoos and Similkameen show decreases.

Up to the last few years, when the inauguration of quartz mining in the province on a large scale introduced a new factor, the gold produced had practically all come from working the shallower and richer placer

deposits. Of late years, however, many enterprises have been started looking to the hydraulicing of the poorer gravels and to this can be attributed the increase in the output of alluvial gold in the province. PRECIOUS METALS. Gold. British Columbia.

In the Cariboo district, work has been continued on a number of large enterprises which were begun several years ago and on which large outlays are being made. When these preparations are fully completed it is expected that there will be a large increase in the gold yield of this district.

Lode Mining.—The chief centres of production of gold from quartz or lode mining are the Trail Creek division of West Kootenay and the Osoyoos division of Yale, the former supplying about 79 per cent and the latter 16 per cent of the lode mining output. There was a slight decrease in the production from the Rossland ores, although the tonnage of ore treated was greatly increased, while in the Osoyoos division there was an increase of 167 per cent in the gold output. The ores here are largely free milling.

The following tables, taken from the reports of the Minister of Mines for British Columbia, show the production of the Rossland mines and illustrate the average results attained during the past five years.

NET PRODUCTION, PER SMELTER RETURNS.

Year.	Ore, tons, 2,000 lbs.	Gold, oz.	Silver, oz.	Copper, lbs.	Value.
1894	1,856	3,723	5,357	106,229	$ 75,510
1895	19,693	31,497	46,762	840,420	702,459
1896	38,075	55,275	89,285	1,580,635	1,243,360
1897	68,804	97,024	110,068	1,819,586	2,097,280
1898	111,282	87,343	170,804	5,232,011	2,470,811
Total	239,710	274,862	422,216	9,578,881	6,589,420

AVERAGE NET SMELTER RETURNS, OR ACTUAL YIELD PER TON.

Year.	Gold.	Silver.	Copper.	Value.
	Ounces.	Ounces.	%	$
1894	2·00	2·89	2·85	40.69
1895	1·60	2·41	2·10	35.67
1896	1·45	2·34	2·08	32.65
1897	1 42	1·60	1·32	30.48
1898	·78	1·54	2·35	22·10
Average 239,710 tons	1·15	1·76	2·00	27.49

PRECIOUS METALS.

SILVER.

Silver.

There was a decrease in the production of silver in Canada in 1898 as compared with 1897 of 1,106,113 ounces. The production in 1897, was 5,558,446 ounces valued at $3,323,395 or 59·79 cents per ounce, and in 1898 4,452,333 ounces valued at $2,593,929 or 58·26 cents per ounce, the decrease being about 20 per cent in quantity and $729,466 or nearly 22 per cent in value.

As usual, the greater part of the output, or over 98 per cent, came from the province of British Columbia. There was a small revival of silver mining in Ontario, the production in that province being 85,000 ounces in 1898 as compared with 5,000 ounces in 1897.

The statistics of the production of silver for the past twelve years are given in Table 13 below and the variations are exhibited graphically in Table G.

TABLE 13.

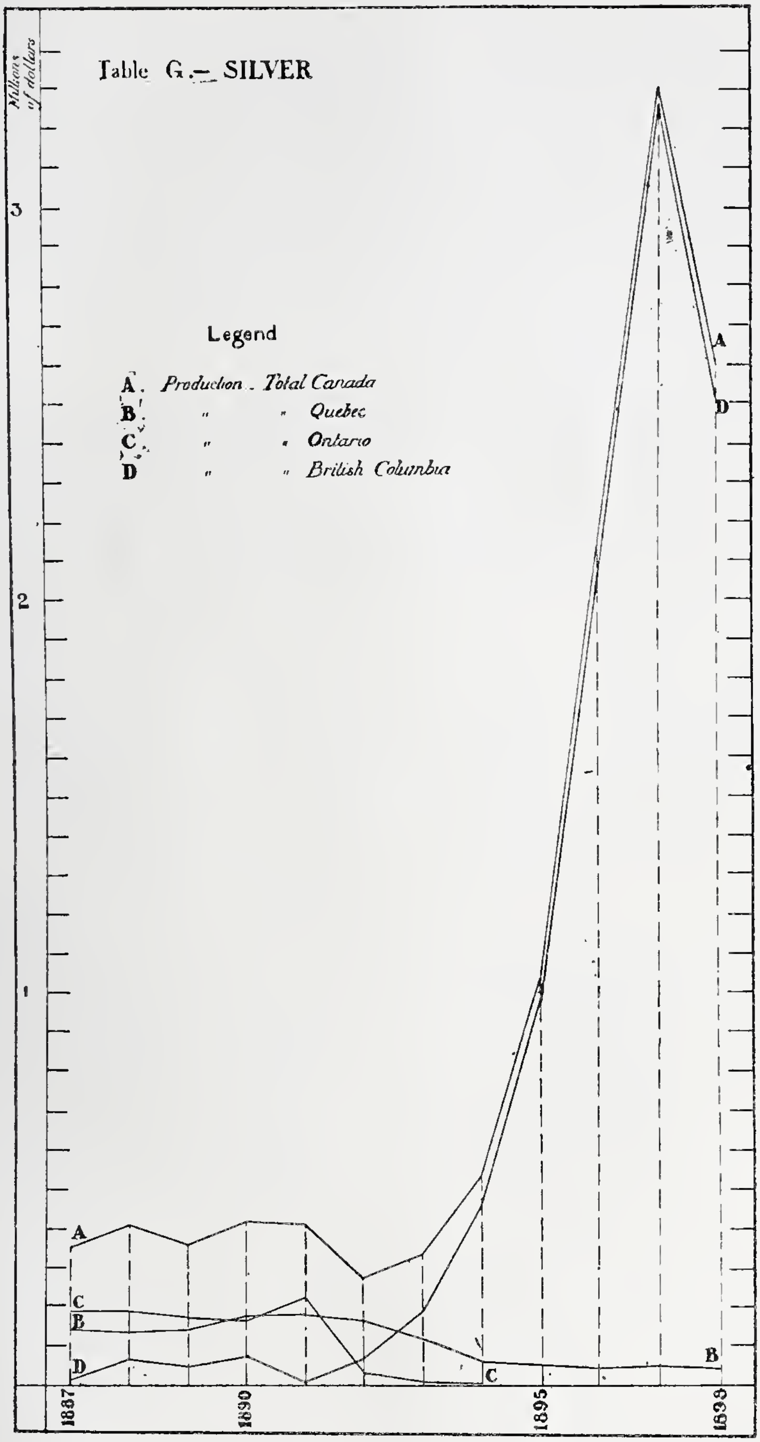
PRECIOUS METALS.

Production.

SILVER:—ANNUAL PRODUCTION.

Calendar Year.	Ontario.		Quebec.		British Columbia.		Total.	
	Ounces.	Value.	Ounces.	Value.	Ounces.	Value.	Ounces.	Value.
1887..	190,495	$186,304	146,898	$143,666	17,690	$17,301	355,083	$347,271
1888..	208,064	195,580	149,388	140,425	79,780	74,993	437,232	410,998
1889..	181,609	169,986	148,517	139,012	53,192	49,787	383,318	358,785
1890..	158,715	166,016	171,545	179,436	70,427	73,666	400,687	419,118
1891..	225,633	222,926	185,584	183,357	3,306	3,266	414,523	409,549
1892..	41,581	36,425	191,910	168,113	77,160	67,592	310,651	272,130
1893..	....	8,689	....	126,439	....	195,000	....	330,128
1894..	....	....	101,318	63,830	746,379	470,219	847,697	534,049
1895 .	....	....	81,753	53,369	1,496,522	976,930	1,578,275	1,030,299
1896..	....	....	70,000	46,942	3,135,343	2,102,561	3,205,343	2,149,503
1897..	5,000	2,990	80,475	48,116	5,472,971	3,272,289	5,558,446	3,323,395
1898..	85,000	49,521	74,932	43,655	4,292,401	2,500,753	4,452,333	2,593,929

PRECIOUS METALS.
Silver.
Production.



PRECIOUS METALS.
Silver.
Quebec.

QUEBEC.

The production of Quebec represents the silver contained in the pyrites mined in the Eastern Townships and utilized as a source of sulphur in acid making. Besides the copper carried by these ores they contain a little silver, from 1 to 2 ounces per ton. A reference to the article on pyrites will show that the production of this ore, from which the silver is obtained, has decreased very largely during the past few years, hence the resultant lessening in the output of silver.

Ontario.

ONTARIO.

Silver mining in Ontario, which had been discontinued entirely from 1893 to 1897 began to recover somewhat during the latter year and the old dumps being worked over, some 5,000 ounces were recovered. In 1898, several of the mines in the vicinity of Port Arthur were opened up and a total output of 85,000 ounces is reported.

British Columbia.

BRITISH COLUMBIA.

The production in British Columbia by divisions for 1897 and 1898 was as follows:—

District.	1897.	1898.
	Oz.	Oz.
Kootenay East	116,657	69,780
Kootenay West—		
Ainsworth Division....	525,678	167,147
Nelson "	961,124	692,367
Slocan "	3,641,287	3,068,648
Trail Creek "	110,068	170,804
Other "	116,657	121,510
Yale—Osoyoos Division....	1,174	....
Other districts............	1,426	2,145
Total	5,472,971	4,292,401

A decreased production will be noted in all the divisions with the exception of Trail Creek, and a number of miscellaneous divisions. This decrease in the output of the silver-lead ores has been referred to in the article on lead, and is ascribed in part to the low price of silver in the early part of 1898 and to the uncertainty as to its future value; also in part to restricted shipments, in expectation of cheaper fuel and transportation on the anticipated completion of the Crow's Nest Pass branch of the Canadian Pacific Railway.

PRECIOUS METALS. Silver. British Columbia.

The most important producing division is the Slocan in West Kootenay and the following tables, based on the reports of the Minister of Mines for the province give the production and average yield per ton for the division for the past four years :—

NET PRODUCTION PER SMELTER RETURNS.

Year.	Ore, Tons, 2,000 lbs.	Silver, oz.	Lead, lbs.	Gold, oz.	Values.
1895	9,514	1,122,770	9,666,324	6	$1,045,600
1896	16,560	1,954,258	18,175,074	152	1,854,011
1897	33,567	3,641,287	30,707,705	193	3,280,686
1898	30,691	3,068,648	27,063,595	60	2,619,852
Totals	90,332	9,786,963	85,612,698	411	$8,800,149

ACTUAL YIELD PER TON.

Year.	Silver.	Lead.	Value.
1895	118·0 oz.	50·8%	$109 90
1896	118·0 "	54·9%	111 95
1897	108·5 "	45·7%	97 73
1898	100·0 "	44·1%	85 36
For 90,332 tons	108·3 oz.	47·4%	97 42

The following table, No. 14, gives the exports of silver ores as entered in the Customs returns. When it is remembered that practically all the silver-bearing products of the country are exported, some discrepancies will be noted between tables 13 and 14. The value of the exports appears to be considerably less than the production in the earlier years of the tables and slightly in excess in the latter years. A different basis of valuation adopted will go far towards accounting for the variation in the earlier years, but the same reason can hardly be advanced for the difference in 1895, '96, '97 and '98, since the production is valued at the average final value of the refined metal. The figures of production for British Columbia for these latter years, being known to be based upon smelter returns, can, however, be taken to be quite correct.

PRECIOUS METALS.
Silver.

TABLE 14.

PRECIOUS METALS.

SILVER :—EXPORTS OF ORE.*

Provinces.	Calendar Years.						
	1892.	1893.	1894.	1895.	1896.	1897.	1898.
	$	$	$	$	$	$	$
Ontario	35,992	7,878	....	100	....	5,885	40,298
Manitoba	80	820	....	....	....	....	.. ....
N.-W. Territories	....	....	....	....	....	....	1,212
British Columbia.	20,616	204,997	359,731	994,254	2,271,959	3,570,506	2,860,767
Totals	56,688	213,695	359,731	994,354	2,271,959	3,576,391	2,902,277

* The production of silver given under the heading Quebec, in Table 13, represents the amount of that metal in the pyritous copper ores produced and exported from that province. Being but in small proportion, it is ignored, and does not appear under the heading silver in the export returns.

PYRITES.

PYRITES.

The mines of the Eustis Mining Co. and the Nichols Chemical Co. in the Eastern Townships, province of Quebec, continue to be the source of production of pyrites, statistics of which are given in Table 1 below. The mines are situated in the township of Ascot, in the vicinity of Capelton. The ore, which consists mainly of the sulphides of iron and copper, carries about 42 per cent of sulphur, from 3 to 4 per cent of copper and from 2 to 4 ounces of silver per ton. Although mined primarily for sulphur for use in the manufacture of sulphuric acid, both the copper and silver are extracted with some profit. A small proportion is used in Canada for making sulphuric acid ; but the bulk of the ore is shipped to the manufacturing establishments of the Nichols Company, and to other plants in the United States.

PYRITES.

TABLE 1.

PYRITES.

ANNUAL PRODUCTION.

Production.

Calendar Year.	Tons, 2,000 lbs.	Value.
		$
1886	42,906	193,077
1887	38,043	171,194
1888	63,479	285,656
1889	72,225	307,292
1890	49,227	123,067
1891	67,731	203,193
1892	59,770	179,310
1893	58,542	175,626
1894	40,527	121,581
1895	34,198	102,594
1896	33,715	101,155
1897	38,910	116,730
1898	32,218	128,872

TABLE 2.

PYRITES.

IMPORTS.—BRIMSTONE AND CRUDE SULPHUR.

Imports.

Fiscal Year.	Pounds.	Value.
1880	1,775,489	$27,401
1881	2,118,720	33,956
1882	2,375,821	40,329
1883	2,336,085	36,737
1884	2,195,735	37,463
1885	2,248,986	35,043
1886	2,922,043	43,651
1887	3,103,644	38,750
1888	2,048,812	25,318
1889	2,427,510	34,006
1890	4,440,799	44,276
1891	3,601,748	46,351
1892	4,769,759	67,095
1893	6,381,203	77,216
1894	5,845,463	61,558
1895	4,900,225	56,965
1896	6,934,190	63,973
1897	8,672,751	87,719
1898*	38,026,798	373,786

* Brimstone, crude, or in roll or flour, and sulphur in roll or flour. Duty free.

Salt.

SALT.

There is little change to report in the operation of the salt wells during 1898. The total production was 57,142 tons valued at $248,639 or an average of $4.35 per ton. Compared with 1897 this is an increase of $5,694 tons or 11·3 per cent and in value $22,909 or 10·1 per cent.

The Sussex Salt Works in New Brunswick contiued to supply a small local demand. With this exception the entire production comes from the Ontario fields, returns being received from twelve operators.

The Sarnia Salt Co. has increased its capital to $100,000, and was engaged in reconstruction of works with a view to active operations on a largely extended scale.

No production was reported from the salt springs on the shores of Lake Winnipegosis, Man.

The statistics of production, exports and imports are given in the following tables. The total imports of salt amount to about twice the Canadian production.

It will be noted, however, that all but about 15 per cent of the salt imported comes in free for fishery purposes. The value of the salt otherwise entering into competition with that of Canadian manufacture is only about 13 per cent of the value of the latter.

Production.

Table 1.

Salt.

Production.

Calendar Year.	Tons.	Value.
1886	62,359	$227,195
1887	60,173	166,394
1888	59,070	185,460
1889	32,832	129,547
1890	43,754	198,857
1891	45,021	161,179
1892	45,486	162,041
1893	62,324	195,926
1894	57,199	170,687
1895	52,376	160,455
1896	43,960	169,693
1897	51,348	225,730
1898	57,142	248,639

Salt.

Exports.

TABLE 2.
SALT.
EXPORTS.

Calendar Year.	Bushels.	Value.
1880	467,641	$46,211
1881	343,208	44,627
1882	181,758	18,350
1883	199,733	19,492
1884	167,029	15,291
1885	246,794	18,756
1886	224,943	16,886
1887	154,045	11,526
1888	15,251	3,987
1889	8,557	2,390
1890	6,605	1,667
1891	5,290	1,277
1892	2,000	504
1893	4,940	1,267
1894	4,639	1,120
1895	4,865	959
1896	3,842	899
1897	5,383	1,193
1898	5,202	1,252

Imports.

TABLE 3.
SALT.
IMPORTS—SALT PAYING DUTY.

Fiscal Year.		Pounds.	Value.
1880		726,640	$ 3,916
1881		2,588,465	6,355
1882		3,679,415	12,318
1883		12,136,968	36,223
1884		12,770,950	38,949
1885		10,397,761	31,726
1886		12,266,021	39,181
1887		10,413,258	35,670
1888		10,509,799	32,136
1889		11,190,088	38,968
1890		15,135,109	57,549
1891		15,140,827	59,311
1892		18,648,191	65,963
1893		21,377,339	79,838
1894		15,867,825	53,336
1895		8,498,404	29,881
1896		7,665,257	24,550
1897		11,911,766	33,470
	Duty.		
1898 Salt, coarse, N.E.S	5c. per 100 lbs.	4,432,548	8,970
1898 Salt, fine, in bulk	5c. "	2,212,130	3,476
1898 Salt, N.E.S., in bags, barrels or other packages	7½c. "	4,424,107	20,346
Total		11,068,785	32,792

Salt.

Imports.

TABLE 4.

SALT.

IMPORTS—SALT NOT PAYING DUTY.

Fiscal Year.	Pounds.	Value.
1880	212,714,747	$400,167
1881	231,640,610	488,278
1882	166,183,962	311,489
1883	246,747,113	386,144
1884	225,390,121	321,243
1885	171,571,209	255,719
1886	180,205,949	255,359
1887	203,042,332	285,455
1888	184,166,986	220,975
1889	180,847,800	253,009
1890	158,490,075	252,291
1891	195,491,410	321,239
1892	201,831,217	314,995
1893	191,595,530	281,462
1894	196,668,730	328,300
1895	201,691,248	332,711
1896	205,005,100	338,888
1897	215,844,484	312,117
1898*	202,634,927	293,410

* Salt, imported from the United Kingdom, or any British possession, or imported for the use of the sea or gulf fisheries.

Structural Materials.

STRUCTURAL MATERIALS.

Under this heading are comprised building stone, granites, marbles, slates, flagstones, cements, lime, etc., as well as the manufactures of clay, which include building bricks, tiles, drain-pipe earthenware and coarse pottery.

The industries based on the structural materials are so widespread and are carried on in so many different places, on various scales and often intermittently, that it is impossible to obtain anything like complete returns of quantity or value of the products. The figures of production are therefore to be taken only as rough approximations.

Structural Materials.
Production of Building-stone.

TABLE 1.

STRUCTURAL MATERIALS.

PRODUCTION OF BUILDING STONE.

Calendar Year.	Value.
1886	$ 642,509
1887	552,267
1888	641,712
1889	913,691
1890	964,783
1891	708,736
1892	609,827
1893	1,100,000
1894	1,200,000
1895	1,095,000
1896	1,000,000
1897	1,000,000
1898	1,300,000

Exports of Stone.

TABLE 2.

STRUCTURAL MATERIALS.

EXPORTS OF STONE AND MARBLE, WROUGHT AND UNWROUGHT.

Provinces.	Wrought.		Unwrought.	
	Calendar Years.			
	1897.	1898.	1897.	1898.
Ontario	$2,478	$379	$28,106	$63,755
Quebec	5,889	708	....	....
Nova Scotia	880	932	9,134	885
New Brunswick	150	507	4,793	730
British Columbia	18	....	1	....
Totals	$9,415	$2,526	$42,034	$65,370

Structural Materials.
Imports of Building-stone.

Table 3.

Structural Materials.

Imports of Building Stone.

Fiscal Year.	Value.
1880	$ 35,970
1881	58,149
1882	33,623
1883	35,061
1884	51,088
1885	30,491
1886	41,675
1887	54,368
1888	86,373
1889	100,314
1890	132,155
1891	170,890
1892	95,550
1893	56,510
1894	52,908
1895	44,282
1896	54,130
1897	38,714
1898 { Flagstones, granite and rough freestone, sandstone, and all building stone, not hammered or chiselled. Duty 15 p.c.	$25,322
1898 { Granite and freestones, dressed ; all other building stone dressed, except marble. Duty 20 p.c.	3,173
	$28,495

STRUCTURAL MATERIALS.

Imports of Stone.

TABLE 4.

STRUCTURAL MATERIALS.

IMPORTS OF MANUFACTURES OF STONE OR GRANITE, N.E.S.

Fiscal Year.		Value.
1880		$29,408
1881		36,877
1882		37,267
1883		45,636
1884		45,290
1885		39,867
1886		41,984
1887		41,829
1888		47,487
1889		61,341
1890		84,396
1891		61,051
1892		39,479
1893		49,323
1894		49,510
1895		51,050
1896		51,499
1897		34,026
1898	Granite—Sawn only ... Duty 20 p.c.	$ 390
	Finished and polished ... " 35 p.c.	8,505
	Manufactures of, N.O.P. ... " 35 p.c.	19,314
	Manufactures of stone, N.O.P. ... " 30 p.c.	13,031
		$41,240

Production of Marble.

TABLE 5.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF MARBLE.

Calendar Year.	Tons.	Value.
1886	501	$9,900
1887	242	6,224
1888	191	3,100
1889	83	980
1890	780	10,776
1891	240	1,752
1892	340	3,600
1893	590	5,100
1894	Nil.	Nil.
1895	200	2,000
1896	224	2,405
1897	Nil.	Nil.
1898	Nil.	Nil.

Structural Materials.

Imports of Marble.

Table 6.

Structural Materials.

Imports of Marble.

Fiscal Year.	Duty.	Value.
1880		$ 63,015
1881		85,977
1882		109,505
1883		128,520
1884		108,771
1885		102,835
1886		117,752
1887		104,250
1888		94,681
1889		118,421
1890		99,353
1891		107,661
1892		106,268
1893		96,177
1894		94,657
1895		83,422
1896		90,065
1897		77,150
1898 Marble and manufactures of :—		
Marble sawn only	20 p. c.	$64,157
Finished and polished	35 "	7,778
Rough, not hammered or chiselled	15 "	1,839
Manufactures of, N.O.P.	35 "	22,120
Total, marble and manufactures of		$95,894

Production of Granite.

Table 7.

Structural Materials.

Annual Production of Granite.

Calendar Year.	Tons.	Value.
1886	6,062	$63,309
1887	21,217	142,506
1888	21,352	147,305
1889	10,197	79,624
1890	13,307	65,985
1891	13,637	70,056
1892	24,302	89,326
1893	22,521	94,393
1894	16,392	109,936
1895	19,238	84,838
1896	18,717	106,709
1897	10,345	61,934
1898	23,897	81,073

Structural Materials.
Production of Slate.

TABLE 8.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF SLATE.

Calendar Year.	Tons.	Value.
1886	5,345	$64,675
1887	7,357	89,000
1888	5,314	90,689
1889	6,935	119,160
1890	6,368	100,250
1891	5,000	65,000
1892	5,180	69,070
1893	7,112	90,825
1894	....	75,550
1895	....	58,900
1896	....	53,370
1897	....	42,800
1898	....	40,791

Exports of Slate.

TABLE 9.

STRUCTURAL MATERIALS.

EXPORTS OF SLATE.

Calendar Year.	Tons.	Value.
1884	539	$6,845
1885	346	5,274
1886	34	495
1887	27	373
1888	22	475
1889	26	3,303
1890	12	153
1891	15	195
1892	87	2,038
1893	178	3,168
1894	187	3,610
1895	36	574
1896	301	8,913
1897	Nil.	Nil.
1898	Nil.	Nil.

Structural Materials.
Imports of Slate.

Table 10.

Structural Materials.

Imports of Slate.

Fiscal Year.	Value.
1880	$21,431
1881	22,184
1882	24,543
1883	24,968
1884	28,816
1885	28,169
1886	27,852
1887	27,845
1888	23,151
1889	41,370
1890	22,871
1891	46,104
1892	50,441
1893	51,179
1894	29,267
1895	19,471
1896	24,176
1897	21,615

		Duty.	
1898	Slate and manufactures of—		
	Mantels	30 p. c.	$ 554
	Roofing slate	25 p. c. not over 75c. per square	3,577
	School writing slates	25 p. c.	10,455
	Slate pencils	25 p. c.	3,032
	Slate of all kinds and manufactures of, N.E.S.	30 p. c.	7,289
	Total		$24,907

STRUCTURAL MATERIALS.

Production of Flagstone.

TABLE 11.

STRUCTURAL MATERIALS.

PRODUCTION OF FLAGSTONE.

Calendar Year.	Quantity, Sq. ft.	Value.
1886	70,000	$ 7,875
1887	116,000	11,600
1888	64,800	6,580
1889	14,000	1,400
1890	17,865	1,643
1891	27,300	2,721
1892	13,700	1,869
1893	40,500	3,487
1894	152,700	5,298
1895	80,005	6,687
1896	....	6,710
1897	....	7,190
1898	....	4,250

Imports of Flagstone

TABLE 12.

STRUCTURAL MATERIALS.

IMPORTS OF FLAGSTONE.

Fiscal Year.	Tons.	Value.
1881	23	$ 241
1882	90	848
1883	10	99
1884	137	1,158
1885	205	1,756
1886	1,602	9,443
1887	1,316	10,966
1888	2,642	21,077
1889	1,669	15,451
1890	5,665	48,995
1891	3,770	36,348
1892	1,571	15,048
1893	884	8,500
1894	218	2,429
1895	15	84
1896	Nil.	Nil.
1897	13	227
1898*	587	1,540

* Flagstones, dressed. Duty, 20 p.c.

Cement.—The cement industry was carried on in 1898 with increased production and higher prices. The number of works engaged in manufacturing was the same as during the previous year viz.: six in Ontario, two in Quebec and one in British Columbia. Natural rock cement is made at four works in Ontario and one in Quebec, while

Structural Materials.
Cement.

Portland cement is made by two works in Ontario, two in Quebec and one in British Columbia.

The production for the year is given in Table 13, below. The increase in the production of natural rock cement over the previous year was nearly 2 per cent in quantity and over 11 per cent in value while the increase in Portland cement was over 36 per cent in quantity and nearly 55 per cent in value. The average price per barrel of natural rock cement was in 1898 about 84 cents and of Portland cement nearly $2. Of the total production over 87 per cent was produced in Ontario.

Although the production of cement has increased considerably the imports have increased in like proportion. The imports of Portland cement in the fiscal year 1897 were of the value of $252,587 and in 1898 $355,264 the increase being $102,677 or over 40 per cent.

Table 13.

Structural Materials.

Annual Production of Cement.

Calendar Year.				Barrels.	Value.
1887				69,843	$ 81,909
1888				50,668	35,593
1889				90,474	69,790
1890				102,216	92,405
1891				93,473	108,561
1892				117,408	147,663
1893				158,597	194,015
1894				108,142	144,637
1895				128,294	173,675
1896				149,090	201,651
		Barrels.	Value.		
1897	Natural	85,450	$ 65,893	205,213	$275,273
	Portland	119,763	209,380		
1898	Natural	87,125	73,412	250,209	397,580
	Portland	163,084	324,168		

STRUCTURAL MATERIALS.
Cement.

TABLE 14.

STRUCTURAL MATERIALS.

EXPORTS OF CEMENT.

Province.	Calendar Year.					
	1893.	1894.	1895.	1896.	1897.	1898.
Ontario...	$ 718	$339	$662	$484	$535	$632
Quebec	386	42	30	625	109	604
Nova Scotia....	68	101	245	219	....	881
Totals....	$1,172	$482	$937	$1,328	$644	$2,117

TABLE 15.

STRUCTURAL MATERIALS.

IMPORTS OF CEMENT IN BULK OR BAGS.

Fiscal Year.	Bushels.	Value.
1880.............	65	$ 28
1881.....	579	298
1882.............	386	86
1883..	1,759	548
1884..	4,626	1,236
1885.	4,598	1,315
1886.............	6,808	1,851
1887.....	5,421	1,419
1888.............	23,919	5,787
1889..	32,818	10,668
1890....	21,055	5,443
1891.............	11,281	2,890
1892	14,351	3,394
1893	12,534	2,909
1894.............	9,027	2,618
1895.....	....	2,112
1896.......	....	3,672
1897.............	....	4,318
1898*......... ..	....	3,263

*Cement, N.E.S., duty 20 p.c.

Structural Materials.
Cement.

TABLE 16.

STRUCTURAL MATERIALS.

IMPORTS OF HYDRAULIC CEMENT.

Fiscal Year.	Barrels.	Value.
1880	10,034	$ 10,306
1881	7,812	7,821
1882	11,945	13,410
1883	11,659	13,755
1884	8,606	9,514
1885	5,613	5,396
1886	6,164	6,028
1887	6,160	8,784
1888	5,636	7,522
1889	5,835	7,467
1890	5,440	9,048
1891	3,515	6,152
1892	2,214	2,782
1893	4,896	8,060
1894	1,054	985
1895	5,333	7,001
1896	5,688	8,948
1897	2,494	3,937
	Cwt.	
1898 (cement, hydraulic or waterlime)*	16,033	7,097

*Duty 12½c. per 100 lbs.

TABLE 17.

STRUCTURAL MATERIALS.

IMPORTS OF PORTLAND CEMENT.

Fiscal Year.	Barrels.	Value.
1880	....	$ 55,774
1881	....	45,646
1882	....	66,579
1883	....	102,537
1884	....	102,857
1885	....	111,521
1886	....	120,398
1887	102,750	148,054
1888	122,402	177,158
1889	122,273	179,406
1890	192,322	313,572
1891	183,728	304,648
1892	187,233	281,553
1893	229,492	316,179
1894	224,150	280,841
1895	196,281	242,813
1896	204.407	242,409
1897	210,871	252,587
	Cwt.	
1898 (Portland or Roman)*	1,073,058	355,264

* Duty, 12½c. per 100 lbs.

The articles known under the general name of roofing cement, are of varied composition, but generally consist of mica, soapstone, asbestus or some such fire-proof material mixed with tarry cementing matter. In past years small amounts have been manufactured in Canada. STRUCTURAL MATERIALS. Cement.

TABLE 18.

STRUCTURAL MATERIALS.

PRODUCTION OF ROOFING CEMENT.

Calendar Year.	Tons.	Value.
1890	1,171	$ 6,502
1891	1,020	4,810
1892	800	12,000
1893	951	5,441
1894	815	3,978
1895	....	3,153
1896	86	430
1897	Nil.	Nil.
1898	Nil.	Nil.

Lime.—To obtain complete figures of production of this material would be manifestly impossible. There are a few large producers, but a very large amount in the aggregate results from the irregular operations of small operators. The figures in Table 19, therefore, are merely estimates. Tables 20 and 21 need no explanation. Lime.

TABLE 19.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF LIME.

Calendar Year.	Value.
1886	$283,755
1887	394,859
1888	339,951
1889	362,848
1890	412,308
1891	251,215
1892	411,270
1893	900,000
1894	900,000
1895	700,000
1896	650,000
1897	650,000
1898	650,000

Structural Materials.
Lime.

TABLE 20.

STRUCTURAL MATERIALS.

EXPORTS OF LIME.

Province.	Calendar Year.			
	1895.	1896.	1897.	1898.
Ontario	$ 25,257	$25,500	$17,730	$ 31,465
Quebec	23,047	18,067	21,786	15,800
Nova Scotia	1,468	3,195	2,390	245
New Brunswick	21,891	24,058	11,021	2,047
Manitoba	30	....	250	....
British Columbia	4	....	....	37
Totals	$ 71,697	$ 70,820	$ 53,177	$49,594

TABLE 21.

STRUCTURAL MATERIALS.

IMPORTS OF LIME.

Fiscal Year.	Barrels.	Value.
1880	6,100	$ 6,013
1881	5,796	4,177
1882	5,064	5,365
1883	7,623	9,224
1884	10,804	11,200
1885	12,072	11,503
1886	11,021	9,347
1887	10,835	8,524
1888	10,142	7,537
1889	13,079	9,363
1890	8,149	5,360
1891	6,259	4,273
1892	6,132	4,241
1893	6,879	4,917
1894	6,766	4,907
1895	12,008	5,743
1896	10,239	7,331
1897	16,108	10,529
1898 ...Duty 20 p.c.	12,850	9,002

Clay.

Clay Products.—The available statistics regarding the various clay products will be found in the accompanying tables, Nos. 22 to 29. As in the case of lime, before mentioned, the figures quoted for the value of bricks produced are estimated, the data relating to this industry being very imperfect.

STRUCTURAL MATERIALS.
Clay.

Under this heading are comprised those materials going by this name which are adapted to the manufacture of bricks, earthenware, tiles, sewer pipes, &c. They can be roughly divided into three classes, viz., brick clays, refractory clays, and pottery or china-clay.

Clays of the first class are widely distributed throughout Canada, although naturally they have received more attention and development in the more thickly settled parts of Ontario, Quebec and eastern Provinces, than in the western part of the Dominion.

TABLE 22.

STRUCTURAL MATERIALS.

ANNUAL PRODUCTION OF BUILDING BRICKS.

Calendar Year.	Value.
1886	$ 873,600
1887	986,689
1888	1,036,746
1889	1,273,884
1890	1,266,982
1891	1,061,536
1892	1,251,934
1893	1,800,000
1894	1,800,000
1895	1,670,000
1896	1,600,000
1897	1,600,000
1898	1,900,000

TABLE 23.

STRUCTURAL MATERIALS.

EXPORTS OF BRICK.

Province.	CALENDAR YEARS.									
	1894.		1895.		1896.		1897.		1898.	
	M	Value	M	Value	M	Value	M	Value	M	Value
		$		$		$		$		$
Ontario	280	1,257	1,053	4,420	266	1,473	178	940	9	59
Quebec	68	917	82	1,092	41	200	316	1,114	16	88
Nova Scotia	489	3,252	199	834	600	3,276	31	285	11	74
New Brunswick	258	1,979	321	2,319	76	729	48	340	23	155
British Columbia	....	....	....	....	....	....	....	....	6	66
Totals	1,095	7,405	1,655	8,665	983	5,678	573	2,679	65	442

Structural Materials.

Building Brick.

Table 24.

Structural Materials.

Imports of Building Brick.

Fiscal Year.	Value.
1880	$ 2,067
1881	4,281
1882	24,572
1883	14,234
1884	20,258
1885	14,632
1886	5,929
1887	2,440
1888	20,720
1889	24,585
1890	12,500
1891	9,744
1892	5,075
1893	14,108
1894	18,320
1895	4,705
1896	23,189
1897	10,336
1898. ....Duty 20 p.c.	6,652

Imports of paving brick in 1898: Value, $2,337; duty, 20 p.c.

Terra Cotta.

Table 25.

Structural Materials.

Production of Terra Cotta, &c.

Calendar Year.	Value.
1888	$ 49,800
1889	Not available.
1890	90,000
1891	113,103
1892	97,239
1893	55,704
1894	65,600
1895	195,123
1896	83,855
1897	155,595
1898	167,902

STRUCTURAL MATERIALS.
Sewer Pipes.

TABLE 26.

STRUCTURAL MATERIALS.

PRODUCTION OF SEWER PIPES, &C.

Calendar Year.	Value.
1888	$266,320
1889	Not available.
1890	348,000
1891	227,300
1892	367,660
1893	350,000
1894	250,325
1895	257,045
1896	153,875
1897	164,250
1898	181,717

TABLE 27.

STRUCTURAL MATERIALS.

IMPORTS OF DRAIN TILES AND SEWER PIPES.

Fiscal Year.		Duty.	Value.
1880			$ 33,796
1881			37,368
1882			70,065
1883			70,699
1884			71,755
1885			69,589
1886			57,953
1887			71,203
1888			101,257
1889			83,215
1890			77,434
1891			87,195
1892			59,537
1893			39,001
1894			24,625
1895			21,053
1896			19,296
1897			34,286
1898	Drain tile, not glazed	20 p. c.	$ 157
1898	Drain pipes, sewer pipes, chimney linings or vents, chimney tops and inverted blocks, glazed or unglazed	35 "	29,454
	Total		$29,611

STRUCTURAL MATERIALS.

Pottery.

TABLE 28.

ANNUAL PRODUCTION OF POTTERY.

Calendar Year.	Value.
1888	$ 27,750
1889	Not available.
1890	195,242
1891	258,844
1892	265,811
1893	213,186
1894	162,144
1895	151,588
1896	163,427
1897	129,629
1898	214,675

Earthenware.

TABLE 29.

IMPORTS OF EARTHENWARE.

Fiscal Year.		Duty.	Value.
1880			$322,333
1881			439,029
1882			646,734
1883			657,886
1884			544,586
1885			511,853
1886			599,269
1887			750,691
1888			697,082
1889			697,949
1890			695,206
1891			634,907
1892			748,810
1893			709,737
1894			695,514
1895			547,935
1896			575,493
1897			595,822
1898	Earthenware and china :—		
	Baths, tubs and washstands, of earthenware, stone, cement or clay, or of other material, N.O.P.	30 p.c.	$ 7,080
	Brown or coloured earthen and stoneware, and Rockingham ware	30 p.c.	20,309
	Decorated, printed or sponged, and all earthenware, N.E.S	30 p.c.	185,727
	Demijohns, churns and crocks	30 p.c.	2,707
	White granite or ironstone ware, C.C. or cream coloured ware	30 p.c.	176,074
	China and porcelain ware	30 p.c.	186,071
	Earthenware tiles	35 p.c.	33,632
	Manufactures of earthenware, N.E.S.	30 p.c.	64,274
	Total	....	$675,874

STRUCTURAL MATERIALS.

Sand and Gravel.

Sand and Gravel.—It is unnecessary to point out that the exports given below would, of course, represent but a fraction of the amounts of these materials actually put to use throughout the country year by year. Even were it not worth while it would manifestly be impossible to ascertain even approximately the real figures. The exports given, however, represent a recognised industry at a few points in Ontario, where the deposits, being conveniently situated to meet the demand of certain cities in the United States are worked and shipped.

TABLE 30.

STRUCTURAL MATERIALS.

EXPORTS OF SAND AND GRAVEL.

Calendar Year.		Tons.	Value.
			$
1893		329,116	121,795
1894		324,656	86,940
1895		277,162	118,359
1896		224,769	80,110
1897		152,963	76,729
1898	Ontario	163,839	84,085
	Quebec	1,684	5,291
	Nova Scotia	231	922
	New Brunswick	200	200
	Manitoba	....	......
	British Columbia	....	....
	Total	165,954	90,498

MISCELLANEOUS.

MISCELLANEOUS.

Antimony.

Antimony.—After an interval of six years the antimony mines at West Gore, in the county of Hants, were reopened in 1898. A total production of antimony ore of 1,200 long tons is reported containing 11 per cent antimony and running about 18 dwts. in gold. The ore was sold in London.

These mines were first opened up in 1884 and were known as the Rawdon mines. Some considerable shipments were made for a few years, but production gradually fell until in 1891 it ceased altogether and was only renewed during the present year (1898).

MISCELLANEOUS.
Antimony.

TABLE 1.

MISCELLANEOUS.

ANNUAL PRODUCTION OF ANTIMONY ORE.

Calendar Year.	Tons.	Value.
1886	665	$31,490
1887	584	10,860
1888	345	3,696
1889	55	1,100
1890	26½	625
1891	10	60
1898	1,344	20,000

TABLE 2.

MISCELLANEOUS.

EXPORTS OF ANTIMONY ORES.

Calendar Year.	Tons.	Value.	Calendar Year.	Tons.	Value.
1880	40	$ 1,948	1886	665	$31,490
1881	34	3,308	1887	229	9,720
1882	323	11,673	1888	352½	6,894
1883	165	4,200	1889	30	695
1884	483	17,875	1890	38	1,000
1885	758	36,250	1891*	3½	60
1898 Nova Scotia				1,228	$15,072
1898 New Brunswick				4	223
Total				1,232	$15,295

*No exports between 1891 and 1898.

Miscellaneous.
Antimony.

Table 3.

Miscellaneous.

Imports of Antimony.

Fiscal Year.	Duty.	Pounds.	Value.
1880		42,247	$ 5,903
1881		....	7,060
1882		183,597	15,044
1883		105,346	10,355
1884		445,600	15,564
1885		82,012	8,182
1886		89,787	6,951
1887		87,827	7,122
1888		120,125	12,242
1889		119,034	11,206
1890		117,066	17,439
1891		114,084	17,483
1892		180,308	17,680
1893		181,823	14,771
1894		139,571	12,249
1895		79,707	6,131
1896		163,209	9,557
1897		134,661	8,031
1898 Antimony, or regulus of, not ground pulverized or otherwise manufactured.	Free.	141,167	$10,449
1898 Antimony salts	"	15,284	1,901
Total	....	156,451	$12,350

Arsenic.

Arsenic.—There was no production of arsenic to report for 1898 though a renewal of the industry may be looked for at an early date as several companies in the Hastings district of Ontario were making preparations for its production as a by-product in the treatment of the arsenical gold ores there worked.

MISCELLANEOUS.
Arsenic.

TABLE 4.

MISCELLANEOUS.

ANNUAL PRODUCTION OF ARSENIC.

Calendar Year.	Tons.	Value.
1885	440	$17,600
1886	120	5,460
1887	30	1,200
1888	30	1,200
1889	Nil.	Nil.
1890	25	1,500
1891	20	1,000
1892	Nil.	Nil.
1893	"	"
1894	7	420
1895	Nil.	Nil.
1896	"	"
1897	"	"
1898	"	"

TABLE 5.

MISCELLANEOUS.

IMPORTS OF ARSENIC.

Fiscal Year.	Pounds.	Value.
1880	18,197	$ 576
1881	31,417	1,070
1882	138,920	3,962
1883	51,953	1,812
1884	19,337	773
1885	49,080	1,566
1886	30,181	961
1887	32,436	1,116
1888	27,510	1,016
1889	69,269	2,434
1890	138,509	4,474
1891	115,248	4,027
1892	302,958	9,365
1893	447,079	12,907
1894	292,505	10,018
1895	1,115,697	31,932
1896	664,854	27,523
1897	152,275	8,378
1898 ..... Duty free.	1,291,967	14,270

Felspar.—A production of 2,500 tons is reported, chiefly from West Templeton, Wright county, Quebec. MISCELLANEOUS. Felspar.

For the past two or three years there has been considerable inquiry for this mineral by consumers for use in pottery works and also in making buttons. There would seem to be a possibility of the development of a remunerative industry wherever bodies of felspar of considerable size are located near the railway or other communications. Whilst there is a demand, the value is of course not such as would bear the burden of heavy charges for mining, selection and freight and many known occurrences cannot be now worked on account of disabilities in this direction. A number of specimens of Canadian felspar have been obtained by the Geological Survey and through the kindness of pottery makers burnt in the kiln. Most of these yielded good results, yielding samples slightly fused and glazed white and translucent and free from colouration, so that success merely depends upon being able to turn out large quantities cheaply equal to the specimens tested.

Whilst the figures for 1898, given in Table 6, do not show as large a growth as could be wished, it is hoped that the prospecting still going on will result in finding large bodies of good mineral well enough situated for working profitably.

TABLE 6.

MISCELLANEOUS.

PRODUCTION OF FELSPAR.

Calendar Year.	Tons.	Value.
1890	700	$3,500
1891	685	3,425
1892	175	525
1893	575	4,525
1894	Nil.	Nil.
1895	....	*2,545
1896	972	*2,583
1897	1,400	3,290
1898	2,500	6,250

* Exports.

MISCELLANEOUS.

Fireclay.

Fireclay.—Returns of fireclay production were obtained from Nova Scotia and New Brunswick.

TABLE 7.

MISCELLANEOUS.

PRODUCTION OF FIRECLAY.

Calendar Year.	Tons.	Value.
1889	400	$4,800
1890	Nil.	Nil.
1891	250	750
1892	1,991	4,467
1893	540	700
1894	539	2,167
1895	1,329	3,492
1896	842	1,805
1897	2,118	5,759
1898	670	1,680

Moulding Sand.

Moulding Sand.—The moulding sand production embodied in the below given Table No. 8 is almost all produced in western Ontario, appearing in our railway shipment returns. It is all exported to adjacent points in the United States. There is doubtless more or less of this material mined and used locally at other points, but it is not possible to ascertain the data regulating production.

TABLE 8.

MISCELLANEOUS.

PRODUCTION OF MOULDING SAND.

Calendar Year.	Tons.	Value.
1887	160	$ 800
1888	169	845
1889	170	850
1890	320	1,410
1891	230	1,000
1892	345	1,380
1893	4,370	9,086
1894	6,214	12,428
1895	6,765	13,530
1896	5,739	11,478
1897	5,485	10,931
1898	10,572	21,038

Platinum.—The only production reported in Canada in 1898 was about 100 ounces found in the placer workings of the Similkameen district of British Columbia. MISCELLANEOUS. Platinum.

TABLE 9.

MISCELLANEOUS.

ANNUAL PRODUCTION OF PLATINUM.

Calendar Year.	Value.
1887	$ 5,600
1888	6,000
1889	3,500
1890	4,500
1891	10,000
1892	3,500
1893	1,800
1894	950
1895	3,800
1896	750
1897	1,600
1898	1,500

TABLE 10.

MISCELLANEOUS.

IMPORTS OF PLATINUM.

Fiscal Year.	Value.
1883	$ 113
1884	576
1885	792
1886	1,154
1887	1,422
1888	13,475
1889	3,167
1890	5,215
1891	4,055
1892	1,952
1893	14,082
1894	7,151
1895	3,937
1896	6,185
1897	9,031
*1898	9,781

* Platinum wire and platinum in bars, strips, sheets or plates; platinum retorts, pans, condensers, tubing and pipe, imported by manufacturers of sulphuric acid for use in their works. Duty free.

MISCELLANEOUS. Quartz.

Quartz.—As will be evident from Table 11 below the mining of this mineral has never been other than spasmodic. The small quantity noted for 1898 was chiefly used as a refractory material in connection with the electric manufacture of phosphorous now being carried on at Buckingham, Que., and in the rolling mills in Montreal. The material used by the latter was obtained by quarrying and crushing the the Nepean sandstone near Ottawa.

TABLE 11.

MISCELLANEOUS.

ANNUAL PRODUCTION OF QUARTZ.

Calendar Year.	Tons.	Value.
1890	200	$ 1,000
1891	....	....
1892	....	....
1893	100	500
1894	....	....
1895	....	....
1896	10	50
1897	....	....
1898	284	570

TABLE 12.

MISCELLANEOUS.

IMPORTS OF 'SILEX' CRYSTALLIZED QUARTZ.

Fiscal Year.	Cwt.	Value.
1880	5,252	$ 2,290
1881	3.251	1,659
1882	3,283	1,678
1883	3,543	2,058
1884	3,259	1,709
1885	3,527	1,443
1886	2,520	1,313
1887	14,533	5,073
1888	4,808	2,385
1889	5,130	1,211
1890	1,768	2,617
1891	3,674	1,929
1892	1,429	1,244
1893	2,447	1,301
1894	2,451	1,521
1895	2,882	1,881
1896	3,289	2,174
1897	2,564	3,415
1898 .... Duty free.	3,104	2,773

Soapstone.—As in past years a small amount of this material has been produced. As this subject was dealt with at some length in last year's Report nothing further need be said here. MISCELLANEOUS. Soapstone.

TABLE 13.

MISCELLANEOUS.

ANNUAL PRODUCTION OF SOAPSTONE.

Calendar Year.	Tons.	Value.
1886	50	$ 400
1887	100	800
1888	140	280
1889	195	1,170
1890	917	1,239
1891	Nil	Nil
1892	1,374	6,240
1893	717	1,920
1894	916	1,640
1895	475	2,138
1896	410	1,230
1897	157	350
1898	405	1,000

MISCELLANEOUS.

Tin.

Tin.—As there have as yet been discovered no workable deposits of ores of this metal in Canada there is no production to report.

An idea may be formed of the consumption in Canada of tin and tinware by reference to the figures in the below given table.

TABLE 14.
MISCELLANEOUS.
IMPORTS OF TIN AND TINWARE.

Fiscal Year.	Value.
1880	$ 281,880
1881	413,924
1882	790,285
1883	1,274,150
1884	1,018,493
1885	1,060,883
1886	1,117,368
1887	1,187,312
1888	1,164,273
1889	1,243,794
1890	1,289,756
1891	1,206,918
1892	1,594,205
1893	1,242,994
1894	1,310,389
1895	973,397
1896	1,237,684
1897	1,274,108

		Duty.	
1898	Tin crystals	Free.	$ 2,505
	Tin in blocks, pigs and bars	"	292,344
	Tin plates and sheets	"	1,150,741
	Tin foil	"	24,316
	Tin strip waste	"	7
	Tin and manufactures of :—		
	Tin plate in sheets, decorated	25 p. c.	597
	Tinware, plain, japanned, or lithographed, and all manufactures of tin, N.E.S	25 "	80,341
	Total		1,550,851

Tripolite.

Tripolite.—The production of tripolite from the deposits in Nova Scotia has for the past three years been as follows :

Calendar Year.	Tons.	Value.
		$
1896	664	9,960
1897	15	150
1898	1,017	16,660

MISCELLANEOUS.

Whiting and Chalk.

Whiting and Chalk.—There is a small consumption of these materials in Canada as evidenced by the below given tables of imports. In neither case however is there any production to report.

TABLE 15.

MISCELLANEOUS.

IMPORTS OF WHITING.

Fiscal Year.	Cwt.	Value.
1880	84,115	$26,092
1881	47,480	16,637
1882	36,270	16,318
1883	76,012	29,334
1884	76,268	28,230
1885	67,441	23,492
1886	65,124	25,533
1887	47,246	15,191
1888	76,619	20,508
1889	84,658	22,735
1890	96,243	27,471
1891	84,679	27,504
1892	102,985	26,867
1893	88,835	25,563
1894	103,633	26,649
1895	102,751	25,441
1896	113,791	27,322
1897	102,453	22,541
*1898	166,293	25,761

* Whiting or whitening, gilders' whiting and Paris white. Duty free.

TABLE 16.

MISCELLANEOUS.

IMPORTS OF CHALK.

Fiscal Year.	Value.
1880	$2,117
1881	2,768
1882	2,882
1883	5,067
1884	2,589
1885	8,003
1886	6,583
1887	5,635
1888	5,865
1889	5,336
1890	7,221
1891	8,193
1892	9,558
1893	9,966
1894	11,308
1895	7,730
1896	6,467
1897	7,432
*1898	9,338

* Chalk prepared. Duty 20 p. c.

MISCELLANEOUS.
Zinc.

Zinc.—The deposits of blende and galena on Calumet Island, Pontiac Co., Que., were worked by the Grand Calumet Mining Company, Limited, and about 1,100 long tons of ore were shipped averaging about 32 per cent zinc, besides silver and lead, giving a total output of zinc of 394 tons of 2,000 lbs.

TABLE 17.

MISCELLANEOUS.

IMPORTS OF ZINC IN BLOCKS, PIGS AND SHEETS.

Fiscal Year.	Cwt.	Value.
1880	13,805	$67,881
1881	20,920	94,015
1882	15,021	76,631
1883	22,765	94,799
1884	18,945	77,373
1885	20,954	70,598
1886	23,146	85,599
1887	26,142	98,557
1888	16,407	65,827
1889	19,782	83,935
1890	18,236	92,530
1891	17,984	105,023
1892	21,881	127,302
1893	26,446	124,360
1894	20,774	90,680
1895	15,061	63,373
1896	20,223	80,784
1897	11,946	57,754
1898 .Duty free	35,148	112,785

Miscellaneous.
Zinc.

TABLE 18.

MISCELLANEOUS.

IMPORTS OF SPELTER.

Fiscal Year.	Cwt.	Value.
1880	1,073	$ 5,310
1881	2,904	12,276
1882	1,654	7,779
1883	1,274	5,196
1884	2,239	10,417
1885	3,325	10,875
1886	5,432	18,238
1887	6,908	25,007
1888	7,772	29,762
1889	8,750	37,403
1890	14,570	71,122
1891	6,249	31,459
1892	13,909	62,550
1893	10,721	49,822
1894	8,423	35,615
1895	9,249	30,245
1896	10,897	40,548
1897	8,342	32,826
*1898 ....Duty free	2,794	13,561

* Spelter in blocks and pigs.

TABLE 19.

MISCELLANEOUS.

IMPORTS OF ZINC, MANUFACTURES OF.

Fiscal Year.	Duty.	Value.
1880		$ 8,327
1881		20,178
1882		15,526
1883		22,599
1884		11,952
1885		9,459
1886		7,345
1887		6,561
1888		7,402
1889		7,233
1890		6,472
1891		7,178
1892		7,563
1893		7,464
1894		6,193
1895		5,581
1896		6,290
1897		5,145
1898 Zinc, seamless drawn tubing	Free.	$ 3,540
1898 " manufactures of, N.O.P.	25 p. c.	6,963
Total		10,503

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(New Series).

ABBREVIATIONS.

Al.	District of Alberta.	N.W.T.	North-west Territory.
B.C.	Province of British Columbia.	N.E.T.	North-east Territory.
M.	Province of Manitoba.	O.	Province of Ontario.
N.B.	Province of New Brunswick.	P.E.I.	Prince Edward Island.
N.S.	Province of Nova Scotia.	Q.	Province of Quebec.